JOHNS HOPKINS UNIVERSITY

DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING

UNDERGRADUATE ADVISING MANUAL

2019-2020

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ADVISING GUIDE FOR UNDERGRADUATE MAJORS IN MATERIALS SCIENCE AND ENGINEERING

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INTRODUCTION
DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Materials are essential to the construction of any engineering structure, from the smallest integrated circuit to the largest bridge. In almost every technology, the performance, reliability, or cost is determined by the materials used. As a result, the drive to develop new materials and processes (or to improve existing ones) makes *materials science and engineering* one of the most important and dynamic engineering disciplines.

The central theme of materials science and engineering is that the relationships among the structure, properties, processing, and performance of materials are crucial to their function in engineering structures. *Materials scientists* seek to understand these fundamental relationships, and use this understanding to develop new ways for making materials or to synthesize new materials. *Materials engineers* design or select materials for particular applications and develop improved processing techniques. Since materials scientists and engineers must understand the properties of materials as well as their applications, the field is inherently interdisciplinary, drawing on aspects of almost every other engineering discipline as well as physics, chemistry, and, most recently, biology. Because the field encompasses so many different areas, it is often categorized according to types of materials (metals, ceramics, polymers, semiconductors) or to their applications (biomaterials, electronic materials, magnetic materials, or structural materials).

The department prepares students for successful careers in materials science and engineering, for advanced study in science or engineering, and for professional education in other fields. The goal of the undergraduate program is to provide a rigorous and comprehensive curriculum in materials science and engineering as well as in mathematics, basic sciences, humanities, and social sciences. Our low student-to-faculty ratio allows students close contact with faculty in both classroom and research environments, as well as with other students and researchers in the department. The student is encouraged to proceed at his or her own rate, and to participate in interdisciplinary, interdepartmental, and interschool programs. In the tradition of Johns Hopkins, all of our undergraduate students are encouraged to participate in research, often beginning in their sophomore year, working closely with faculty and graduate students.

In recognition that biomaterials and nanotechnology represent two of the most rapidly developing areas of materials science and engineering, the Department of Materials Science and Engineering currently offers challenging concentrations (tracks) in biomaterials or nanotechnology within its undergraduate program. The successful completion of the Biomaterials Concentration and Nanotechnology Concentration will be formally noted on the student's transcript.

The field of *biomaterials* is concerned with the science and engineering of materials in biology and medicine. Engineered materials are increasingly used in applications such as drug delivery and gene therapy, scaffolds for tissue engineering, replacement body parts as well as biomedical and surgical devices. Biomaterials are an inherently interdisciplinary field that requires deep understanding of the properties of materials in general and the interactions of materials with the biological environment. The Biomaterials Track is designed to provide a firm grounding in the physics, chemistry, and biology of materials, as well as breadth in general engineering, mathematics, humanities, and social science. In addition, students are encouraged to gain hands-on experience in biomaterials research laboratories. The program seeks to educate students to reach the forefront of leadership in the field of biomaterials engineering. While the fundamental principles of materials science still apply, a complete understanding of biomaterials and their interactions with biological environments requires a greater degree of specialization than the standard undergraduate curriculum provides. In recognition of completion of the biomaterials concentration, a student can elect to have his or her academic transcript annotated to indicate a specialty in biomaterials.

Nanotechnology advances the utilization of materials and devices with extremely small dimensions. Nanotechnology is a visionary field, as micro and nanostructured devices impact all fields of engineering, from microelectronics (smaller, faster computer chips) to mechanical engineering (micromotors and actuators) to civil engineering ("smart", self-healing nanocomposite materials for buildings and bridges) to biomedical engineering (biosensors and tissue engineering). Materials Science is central to nanotechnology because the properties of materials can change dramatically when things are made extremely small. This observation is not simply that we need to measure such properties or develop new processing tools to fabricate nanodevices. Rather, our vision is that the wide (and sometimes unexpected!) variety of phenomena associated with nanostructured materials allow us to envision radically new devices and applications that can only be made with nanostructured materials. The Nanotechnology Track encompasses a curriculum designed to train students in the fundamental interdisciplinary principles of materials science including physics and chemistry, and also to expose students to the forefront of nanomaterials research through elective classes as well as in research laboratories. Students in the Nanotechnology Track will be well-prepared for successful careers in materials engineering across a wide range of disciplines. In recognition of completion of the nanotechnology track, a student can elect to have his or her academic transcript annotated to indicate a specialty in nanotechnology.

Whether a student chooses to pursue studies following the standard program, the biomaterials concentration or the nanotechnology concentration, the coursework specified for the degree will provide a firm grounding in the principles of materials science and engineering. The Materials Science and Engineering faculty strives to maintain the Johns Hopkins University tradition: to train a small number of students of highest quality, whose impact on the scientific and engineering community is large compared with the size of the Department and the University. This institutional aspiration can only be realized with the success of our students as they pursue career directions beyond their time at Hopkins. Our degree program is designed to provide an optimum starting point for students with a diversity of career aspirations providing a solid foundation for future career development.

These goals are succinctly stated by our degree Program Educational Objectives. Namely, within 3-5 years of graduation, our graduates will:

1. be engaged in advanced education, research, and development in materials science and engineering, including materials discovery and/or processing, or professional disciplines that benefit from an understanding of materials science and engineering such as business, medicine or law.

2. employ elements of the materials research process in their careers including the use of
    - critical reasoning to identify fundamental issues and establish directions for investigation
    - creative processes to define specific plans for problem solution
    - analytical thought to interpret results and place them within a broader context.

3. demonstrate ethical responsibility and an appreciation for the societal and global impact of their endeavors while maintaining their intellectual curiosity through lifelong learning.

DEPARTMENTAL AND UNIVERSITY ADVISING PROCEDURES

When entering the Department of Materials Science and Engineering you will be assigned an academic advisor who is a full-time faculty member in the Department. Students will plan their programs of study in consultation with their advisors (see sample programs later in this manual). These programs will be designed to meet the University and Departmental degree requirements as well as reflect the individual interests of the student. An anticipated program of study signed by your advisor should be filed as early as possible during your residence, and as subsequent changes are made to the program, it is your responsibility to see that a revised and signed program is filed with your advisor. You must have an approved program on file no later than the semester before you expect to graduate.

Your assigned academic advisor is your primary resource for information regarding your degree program in Materials Science and Engineering and will ensure that you have accurate information regarding degree program requirements. Your advisor can also assist you in course selections and program scheduling so that courses are completed in an appropriate sequence. <u>You will meet with your advisor at least once a semester to plan your course selections for the next semester. After this meeting, your academic advisor will electronically remove your registration hold allowing you to register for courses online. A similar process is followed for the add-drop period at the beginning of each semester. For situations that cannot be resolved using the online system, paper forms are available and your advisor's signature is required on all course registration and course change forms.</u>

You should consult with your advisor when you are in the process of identifying educational opportunities outside the degree program such as internships and research experiences as well as study abroad programs. Your advisor can also serve as a resource for career planning information especially as it applies to graduate studies in materials science and engineering or in related science and engineering fields. General information on career planning can be obtained from the Johns Hopkins Career Center (https://studentaffairs.jhu.edu/careers/). Students interested in pursuing advanced professional studies in medicine or in law are encouraged to contact the Office of Pre-professional Advising (https://studentaffairs.jhu.edu/preprofadvising/) early in their planning process so that entrance requirements for medical and law programs are fulfilled before the fourth year.

While pursuing your degree, you might decide to take selected courses at other universities, transfer the associated credits to Johns Hopkins and use these credits towards completion of your degree requirements. The Whiting School Office of Academic Affairs (https://engineering.jhu.edu/academics/wse-academic-advising/) is available to guide you through this process and can provide you with the appropriate forms. This office also provides information on study abroad programs and can assist you in identifying scholarship opportunities associated with special programs that are available to Hopkins students. This office is responsible for monitoring student progress and will notify those students who are not making satisfactory progress towards their degree and will place them on academic probation if their term grade point average falls below 2.0. This office also provides guidance to students who need assistance in improving their academic performance by referring them to programs designed to refine student work habits. These programs are administered by the Undergraduate Academic Advising Office (http://www.advising.jhu.edu/) and are described in this office's website.

Faculty members in the Department of Materials Science and Engineering are committed to assisting in the development of our students and you should feel comfortable consulting informally with faculty members other than your advisor to obtain ideas and directions for your course choices and career development. If you are inclined to do so, you may formally request a change in faculty advisor by contacting the department chair in writing. Students interested in fulfilling the degree requirements in Materials Science and Engineering in addition to those of another department should consult with the advising coordinator of both departments to determine feasibility. The Advising Coordinator for Materials Science and Engineering is Professor Jonah Erlebacher, jonah.erlebacher-at-jhu.edu, Room 206, Maryland Hall.

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3400 N. Charles St.
Garland Hall Suite 300
Baltimore, MD 21218

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Johns Hopkins Career Center
3400 N. Charles St.
Garland Hall Suite 389
Baltimore, MD 21218

Voice: 410-516-8056
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Office of Pre-Professional Advising
3400 N. Charles St.
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Baltimore, MD 21218

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email: preprofessional-at-jhu.edu

REQUIREMENTS FOR THE BACHELOR OF SCIENCE DEGREE IN MATERIALS SCIENCE AND ENGINEERING

The Department of Materials Science and Engineering offers a program leading to the Bachelor of Science degree. The B.S. for the Materials Science and Engineering degree program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The student must meet the general University requirements for this degree as well as the departmental requirements and must complete the program approved by the student's advisor.

General Degree Requirements for the B.S. Degree

- Complete program of study outlined by concentration (standard, biomaterials or nanotechnology)
- Fulfill the university writing requirement
  Two writing intensive (W) courses, at least 3 credits each
- Fulfill 75 credits earned in courses coded (E), (Q), (N) – at least 30 credits must be outside Materials Science and Engineering, at least 30 credits must be (N) or (Q) with no course counted twice
- Fulfill 18 credits of courses coded (H) or (S) – 6 courses, 3 credits each
- Take a minimum of 126 credits – at least 100 credits must be from Johns Hopkins (for students entering directly from high school)

Degree Requirements for the Department of Materials Science and Engineering

A convenient course-check off list is provided below. Please note the grade requirements associated with the course requirements.

Three B.S. degree tracks are offered by the Department of Materials Science and Engineering.

(1) **Standard Track**. The Standard Track is intended for those students with general interests in materials science and engineering. It permits the student to tailor the degree program by allowing a broad range of choices for upper level science and engineering electives.

(2) **Biomaterials Concentration**. The Biomaterials Track is intended for those students with a focused interest in biomaterials. To receive commendation for completion of the Biomaterials Concentration, the student must complete Molecules and Cells as a Science and Engineering elective, three electives at 300-level or above with a focus on biomaterials, a biomaterials laboratory course and a biomaterials senior design project. **Approval of electives must be made by a student's academic advisor prior to taking the courses, and approval of the senior design project must be pre-approved by the senior design instructor.**

An intent to follow the Biomaterials Concentration in Materials Science and Engineering must be made by the student's 5th semester (1st semester junior year). Students should declare their intent in writing or by e-mail to their department advisors and copy the academic coordinator.

(3) **Nanotechnology Concentration**. The Nanotechnology Concentration is intended for those students with a focused interest in nanomaterials. To receive commendation for completion

of the Nanotechnology Concentration, the student must complete three electives at 300-level or above with a focus on nanotechnology, a nanomaterials laboratory course and a nanotechnology senior design project. **Approval of electives must be made by a student's academic advisor prior to taking the courses, and approval of the senior design project must be pre-approved by the senior design instructor.**

Students must declare their intent to satisfy the requirements of the Nanotechnology Concentration in Materials Science and Engineering by their 5th semester (1st semester junior year). Students should declare their intent in writing or by e-mail to their department advisors and copy the academic coordinator.

Double Majoring in Materials Science & Engineering

A student whose primary major is in another department (either in Engineering or Arts & Sciences) may elect to fulfill the requirements for a major in Materials Science and Engineering as well. Upon graduation, a notation is placed on the student's academic record acknowledging completion of the requirements for the major in MSE. The student receives the degree (BS or BA) associated with his or her primary major. Completing a second major does not entitle the student to a second degree.

To add or drop a second major, complete the appropriate form (available from the Registrar's office). This form must be signed by the chair of the undergraduate program in MSE before it is submitted to the Registrar.

Students double-majoring in MSE are required to fulfill all of the requirements for the MSE Degree, including successful completion of the year-long senior design project. This includes the minimum grade requirement of earning a letter grade of C or higher for the MSE core courses.

In certain cases, a student may petition the Undergraduate Program Committee for an exception to the requirements. The Undergraduate Program Committee considers each such request on a case-by-case basis, and a student should not necessarily expect that his or her request will be granted if it represents a significant deviation from the prescribed program. Students are encouraged to plan their academic coursework carefully and consult with their academic advisors early to avoid difficulties in completing the degree requirements.

Professor Todd Hufnagel (hufnagel-at-jhu.edu) is the academic advisor for all students from other departments pursuing double majors in MSE. If you have any questions about double majoring, please contact him. (Questions regarding your primary major should be addressed to your academic advisor in the corresponding department.) If you do decide to pursue a double major in Materials Science & Engineering, please make an appointment to meet with Professor Hufnagel as early as possible to plan your program of study.

DESCRIPTION OF THE BIOMATERIALS CONCENTRATION

Biomaterials are an exciting and rapidly developing field at the multi-disciplinary interface of Materials Science, Engineering, Biology, Chemistry and Medicine. Our unique biomaterials program is designed to provide a broad educational basis with emphasis on principles and applications of biomaterials. Our biomaterials curriculum covers a variety of topics including biomimetic materials and natural materials, host responses to biomaterials and biocompatibility, and applications of biomaterials, particularly to tissue engineering, drug delivery as well as medical devices and implants. The goal of the Biomaterials Concentration in the Department of Materials Science and Engineering is to train students in the basic principles of materials science and engineering as these principles are applied to develop novel materials that benefit human health.

Biomaterials are an inherently interdisciplinary field that requires deep understanding of the properties of materials in general, and the interactions of materials with the biological environment. The Biomaterials Track is designed to provide a firm grounding in the physics, chemistry, and biology of materials, and well as breath in general engineering, mathematics, humanities and social science. In addition, students are encouraged to gain hands-on experience in biomaterials research laboratories. Students who complete the Biomaterials Track will be well-prepared for successful careers in biomaterials engineering or any biomedical related field. Successful completion of the Biomaterials Concentration will be noted on the student's transcript.

Students interested in satisfying pre-med requirements should coordinate their curriculum with the guidelines offered by the Office of Pre-Professional Advising.

DESCRIPTION OF THE NANOTECHNOLOGY CONCENTRATION

Nanotechnology advances the utilization of materials and devices with extremely small dimensions. Nanotechnology is a visionary field, as micro and nanostructured devices impact all fields of engineering, from microelectronics (smaller, faster computer chips) to mechanical engineering (micromotors and actuators) to civil engineering ("smart", self-healing nanocomposite materials for buildings and bridges) to biomedical engineering (biosensors and tissue engineering).

Materials Science is central to nanotechnology because the properties of materials can change dramatically when things are made extremely small. This observation isn't just that we need to measure such properties or develop new processing tools to fabricate nanodevices. Rather, our vision is that the wide (and sometimes unexpected!) variety of phenomena associated with nanostructured materials allow us to envision radically new devices and applications that can only be made with nanostructured materials.

It is with the goal of developing a broad vision for the application of nanostructured materials that the Department of Materials Science offers a *Nanotechnology Concentration*, a curriculum designed to train students in the fundamental interdisciplinary principles of materials science including physics and chemistry, and also to expose students to cutting edge nanomaterials research, both in elective classes and in research laboratories. Students in the Nanotechnology Concentration will be well-prepared for successful careers in materials engineering across a wide range of disciplines. Successful completion of the Nanotechnology Concentration will be noted on the student's transcript.

Sample Undergraduate Programs for Materials Science and Engineering:
***Standard Track* (For a student beginning with Calculus I)**

First Year Fall		
030.101	Introductory Chemistry I	3
110.108	Calculus I	4
030.105	Intro. Chem. Lab I	1
171.101	General Physics I	4
173.111	General Physics Lab I	1
510.106	Foundations of Materials Science & Engineering*	3
Total		16

*Students are encouraged to take this course, and count it as an unrestricted elective

First Year Spring		
030.102	Introductory Chem. II	3
030.106	Intro. Chem. Lab II	1
171.102	General Physics II	4
173.112	General Physics Lab II	1
110.109	Calculus II	4
500.114	Gateway Computing	3
Total		16

Second Year Fall		
510.311	**Structure of Materials**	**3**
030.205	Intro. Organic Chem. I	4
110.202	Calculus III	4
	Math/Sci/Eng elective	3
	H/S elective	3
Total		17

Second Year Spring		
510.312	**Physical Chemistry of Materials. I: Thermodynamics**	**3**
510.316	**Biomaterials I**	**3**
553.291	Linear Algebra and Differential Equations	4
553.310	Probability and Statistics for Phys. Sci. Eng.	4
	H/S elective	3
Total		17

Third Year Fall		
510.315	**Physical Chemistry of Materials II: Kinetics and Phase Transformations**	**3**
510.313	**Mechanical Properties of Materials**	**3**
510.428	**Materials Science Lab I**	**3**
660.363	Leadership and Management for MSE	3
	Math/Sci/Eng elective	3
Total		15

Third Year Spring		
510.314	**Electronic Properties of Materials**	**3**
510.429	**Materials Science Lab II**	**3**
	H/S elective	3
	Unrestricted elective	3
	Math/Sci/Eng elective	3
Total		15

Fourth Year Fall		
510.433	**Senior Design I**	**3**
510.4##	**MSE elective**	**3**
510.4##	**MSE elective**	**3**
	Unrestricted elective	3
	H/S elective	3
Total		15

Fourth Year Spring		
510.434	**Senior Design II**	**3**
510.4##	**MSE elective**	**3**
510.4##	**MSE elective**	**3**
	H/S elective	3
	H/S elective	3
Total		15
Grand Total		**126**

Sample Undergraduate Programs for Materials Science and Engineering:
Biomaterials Concentration **(For a student beginning with Calculus I)**

First Year Fall		
030.101	Introductory Chemistry I	3
110.108	Calculus I	4
030.105	Intro. Chem. Lab I	1
171.101	General Physics I	4
173.111	General Physics Lab I	1
510.106	Foundations of Materials Science & Engineering*	3
Total		16

*Students are encouraged to take this course, and count it as an unrestricted elective

First Year Spring		
030.102	Introductory Chem. II	3
030.106	Intro. Chem. Lab II	1
171.102	General Physics II	4
173.112	General Physics Lab II	1
110.109	Calculus II	4
500.114	Gateway Computing	3
Total		16

Second Year Fall		
510.311	**Structure of Materials**	**3**
030.205	Intro. Organic Chem. I	4
110.202	Calculus III	4
580.221	Molecules and Cells*	4
	H/S elective	3
Total		18

*This Math/Sci/Eng elective is required for Biomaterials Concentration

Second Year Spring		
510.312	**Physical Chemistry of Materials. I: Thermodynamics**	**3**
510.316	**Biomaterials I**	**3**
553.291	Linear Algebra and Differential Equations	4
553.310	Probability and Statistics for Phys. Sci. Eng.	4
	H/S elective	3
Total		17

Third Year Fall		
510.315	**Physical Chemistry of Materials II: Kinetics and Phase Transformations**	**3**
510.313	**Mechanical Properties of Materials**	**3**
510.428	**Materials Science Lab I**	**3**
660.363	Leadership and Management for MSE	3
	Math/Sci/Eng elective	3
Total		15

Third Year Spring		
510.314	**Electronic Properties of Materials**	**3**
510.429	**Materials Science Lab II**	**3**
	H/S elective	3
	Unrestricted elective	3
	Math/Sci/Eng elective	3
Total		15

Fourth Year Fall		
510.433	**Senior Design I**	**3**
510.4##	**MSE elective (Biomolecular Materials)**	**3**
510.4##	**MSE elective (Chemistry Physics of Polymers)**	**3**
510.4##	**MSE elective (Biomaterials II)**	**3**
	H/S elective	3
Total		15

Fourth Year Spring		
510.434	**Senior Design II**	**3**
510.4##	**MSE elective (Biomaterials Lab)**	**3**
	Unrestricted elective	3
	H/S elective	3
	H/S elective	3
Total		15
Grand Total		**127**

Sample Undergraduate Programs for Materials Science and Engineering:
Nanotechnology concentration **(For a student beginning with Calculus I)**

First Year Fall		
030.101	Introductory Chemistry I	3
110.108	Calculus I	4
030.105	Intro. Chem. Lab I	1
171.101	General Physics I	4
173.111	General Physics Lab I	1
510.106	Foundations of Materials Science & Engineering*	3
Total		16

*Students are encouraged to take this course, and count it as an unrestricted elective

First Year Spring		
030.102	Introductory Chem. II	3
030.106	Intro. Chem. Lab II	1
171.102	General Physics II	4
173.112	General Physics Lab II	1
110.109	Calculus II	4
500.114	Gateway Computing	3
Total		16

Second Year Fall		
510.311	**Structure of Materials**	**3**
030.205	Intro. Organic Chem. I	4
110.202	Calculus III	4
530.201	Statics and Mechanics of Materials	4
	H/S elective	3
Total		18

Second Year Spring		
510.312	**Physical Chemistry of Materials. I: Thermodynamics**	**3**
510.316	**Biomaterials I**	**3**
553.291	Linear Algebra and Differential Equations	4
553.310	Probability and Statistics for Phys. Sci. Eng.	4
	H/S elective	3
Total		17

Third Year Fall		
510.315	**Physical Chemistry of Materials II: Kinetics and Phase Transformations**	**3**
510.313	**Mechanical Properties of Materials**	**3**
510.428	**Materials Science Lab I**	**3**
660.363	Leadership and Management for MSE	3
	Math/Sci/Eng elective	3
Total		15

Third Year Spring		
510.314	**Electronic Properties of Materials**	**3**
510.429	**Materials Science Lab II**	**3**
	H/S elective	3
	Unrestricted elective	3
	Math/Sci/Eng elective	3
Total		15

Fourth Year Fall		
510.433	**Senior Design I**	**3**
510.4##	**MSE elective (Nanomaterials Lab)**	**3**
510.4##	**MSE elective (Materials Characterization)**	**3**
	Unrestricted elective	3
	H/S elective	3
Total		15

Fourth Year Spring		
510.434	**Senior Design II**	**3**
510.4##	**MSE elective (Micro Nano Mater. Devices)**	**3**
510.4##	**MSE elective (Nanoparticles)**	**3**
	H/S elective	3
	H/S elective	3
Total		15
Grand Total		**127**

Requirement Sign-Off Sheet for B.S. in Materials Science and Engineering

Note that this sheet may be replaced by an updated version together with a course substitution/waiver form, in Sept. 2019.

To be filled in by students before meeting with your advisor at the beginning of each semester. For specific classes, place a checkmark on the line. For open electives, fill in the line with the class used to satisfy the requirement. This sheet should be updated each semester by the student's faculty advisor, and used as a graduation check.

Student's Name _________________________Advisor's Name __________________Date_________

MATERIALS SCIENCE CORE CLASSES

- Must be passed with letter grade of C or higher
- 30 credits

510.311	Structure of Materials (3)	_____
510.312	Physical Chemistry of Materials I: Thermodynamics (3)	_____
510.313	Mechanical Properties(3)	_____
510.314	Electronic Properties (3)	_____
510.315	Physical Chemistry of Materials II: Kinetics and Phase Transformations (3)	_____
510.316	Biomaterials I (3)	_____
510.428	Materials Science Lab I (3)	_____
510.429	Materials Science Lab II (3)	_____
510.433 (or 438/440)	Senior Design/Research I (3)	_____
510.434 (or 439/441)	Senior Design/Research II (3)	_____

- *See above for senior design requirements specific to the Biomaterials and Nanotechnology tracks.*

UPPER LEVEL MATERIALS SCIENCE ELECTIVES

- Letter grade of C or higher
- 300-level or higher
- relevant courses in other departments with prior permission
- 12 credits

Materials Elective #1 (3)	_____
Materials Elective #2 (3)	_____
Materials Elective #3 (3)	_____
Materials Elective #4 (3)	_____

- *Independent research can only count toward three (3) credits of this requirement.*
- *For the Biomaterials and Nanotechnology Concentrations, three electives at 300-level or higher are required. Independent Research can only count toward three (3) credits of the 9 credits required for Bio/Nano electives.*

BASIC SCIENCES AND ENGINEERING

- Letter grade of C- or higher
- 28 credits

171.101	General Physics I (4)	_____
171.102	General Physics II (4)	_____
173.111	General Physics Laboratory I (1)	_____
173.112	General Physics Laboratory II (1)	_____
030.101	Intro Chemistry I (3)	
030.102	Intro Chemistry II (3)	_____
030.105	Introductory Chem. Lab I (1)	_____
030.106	Introductory Chem. Lab II (1)	_____
030.205	Introductory Organic Chemistry I (4)	_____
500.114	Gateway Computing (3)	_____
660.363	Leadership and Management for Materials Science and Engineering (3)	_____

MATHEMATICS

- Letter grade of C- or higher
- 20 credits

110.108	Calculus I (4)	_____
110.109	Calculus II (4)	_____
110.202	Calculus III (4)	_____
553.291	Linear Algebra and Differential Equations (4)	_____
553.310	Probability & Statistics for Phys. Sci. Eng. (4)	_____

HUMANITIES (H OR S)

- Letter grade of C- or higher required if taken for letter grade; S required if taken S/U
- 18 credits

Humanities Elective #1	_____
Humanities Elective #2	_____
Humanities Elective #3	_____
Humanities Elective #4	_____
Humanities Elective #5	_____
Humanities Elective #6	_____

(Introductory language courses, even if not w/ H or S designator, can substitute for H designated courses)

GENERAL MATHEMATICS, SCIENCE AND ENGINEERING ELECTIVES

- Three courses of 200- level or above in engineering, natural sciences or mathematics

- Letter grade of C- or higher required if taken for letter grade; S required if taken S/U
- 9 credits

Science Elective #1 (3) _____
Science Elective #2 (3) _____
Science Elective #3 (3) _____

At least one of the three electives must be from another department in WSE (to ensure the exposure to another engineering field)

For Biomaterials Concentration, one of the three must be
580.221 Molecules and Cells (4)
(students can substitute Cell Biology+Biochemistry for Mol & Cells)

For other students, a possible choice is 530.201 Statics and Mechanics (4)

UNRESTRICTED ELECTIVES

- 9 credits of unrestricted electives
- Letter grade of C- or higher required if taken for letter grade; S required if taken S/U

Unrestricted Elective #1 (3) _____
Unrestricted Elective #2 (3) _____
Unrestricted Elective #3 (3) _____

- A student who has taken Foundations of MSE may count it toward one unrestricted elective.

TOTAL NUMBER OF REQUIRED CREDITS **126**
(**127** for biotrack)

Additional independent research credits can be counted towards General Math, Sci and Eng electives or Unrestricted electives: 12 is the upper limit of the number of such research credits.

Regarding letter grade versus S/U: Students are encouraged to challenge themselves by taking courses that are outside of their core area or at higher level than they might otherwise consider. Such courses may be taken with the S/U option. The JHU policy is that only one course per semester or summer may be taken for S/U credit. However, an eligible student who registers for a course that is only offered for S/U credit may select an additional S/U course in the same semester. For MSE, all the core requirements should be taken for a letter grade. The electives that can be taken S/U are specified in the list above (Gen. Math Sci. & Eng. Electives, Humanities, and Unrestricted electives).

This sign-off sheet will be used as a graduation check, and certification signatures are required for graduation from the following two independent faculty members.

Certification by Faculty Advisor: Name ____________ Signature _____________ Date ________

Certification by Chair of
Undergraduate Program Committee: Name ____________ Signature _____________ Date_________

ELECTIVES FOR NANOTECHNOLOGY AND BIOMATERIALS CONCENTRATIONS

Course Offering Schedule (as of July 1, 2019)

Course Number	Course Title	Instructor	Offering
Nanotechnology Concentration (select 3, plus 510.442)			(plans may change)
510.442	Nanomaterials Lab	McGuiggan	Fall every year
510.427	Chemistry of Nanomaterials	Hall	TBA
510.422	Micro- and Nano- Structured Materials and Devices	Hall	Spring every year
510.403	Materials Characterization	McGuiggan	Fall every year
510.405	Materials Science of Energy Technologies	Erlebacher	TBA
510.421	Nanoparticles	Wilson	TBA
510.420	Stealth Science and Engineering	Spicer	Fall 2020
510.451	Quantum Physical Interactions	Spicer	TBA
510.415	Chemistry of Materials Synthesis	Katz	Fall 2019
510.457	Materials Science of Thin Films	Weihs	TBA
530.417	Fabricatology – Advanced Materials Processing	Kang	Spring
530.495	Microfabrication Laboratory	Wang	Fall (usually)
540.403	Colloids and Nanoparticles	Bevan	Spring (usually)
540.415	Interfacial Nano Systems	Frechette	Fall (usually)
Biomaterials Concentration (select 3, plus 510.430)			
510.430	Biomaterials Laboratory	Hristova	Spring every year
510.407	Biomaterials II	Gu	Fall every year
510.426	Biomolecular Materials	Hristova	Fall every year
510.435	Mechanical Properties of Biomaterials	Weihs	Fall 2019
580.441	Cellular Engineering	Green/Yarema	Fall (usually)
580.442	Tissue Engineering	Elisseeff/Grayson	Spring (usually)
540.459	Biotechnology in Regenerative Medicine	Gerecht	Spring (usually)
540.426	Biomacromolecules at the Nanoscale	Wirtz	TBA
510.437	Biosensor Materials and Mechanisms	Katz	TBA
510.415	Chemistry of Materials Synthesis	Katz	Fall 2019
540.403	Colloids and Nanoparticles	Bevan	Spring
580.452	Biomedical Applications of Glycoengineering	Yarema	Spring (usually)
580.452	Cell and Tissue Engineering Lab (4)	Haase	Spring/Fall
540.465	Engineering Principles of Drug Delivery	Sofou	Fall/Spring
540.428	Supramolecular Materials and Nanomedicine	Cui	Spring
540.462	Polymer Design and Bioconjugation	Singh	Fall
540.405	The Design of Biomolecular Systems	Schulman	Spring (usually)
530.445	Intro to Biomechanics	MechE faculty	Fall (usually)

This list is NOT meant to be exhaustive. Other courses on campus can be selected, as long as they focus on bio or nano (email Prof. E. Ma, EMA@JHU.EDU if you have questions).

RECEIVING CREDITS FOR RESEARCH IN MSE

Independent Research in MSE (or Design Team Project) aims to provide more scope and depth in the MSE curriculum, helping students to improve their problem-solving skills and the ability to apply theoretical knowledge. Through research in labs under faculty guidance, a student taking this course should learn to be able to:

1) articulate a materials research question, with a working hypothesis
2) execute a literature search related to the topic selected with a clear explanation how the project fills a knowledge gap
3) communicate confidently and effectively with mentors and team mates
4) identify appropriate research methodologies and lab skills/tools, and use them for the project chosen
5) work collaboratively with other researchers in the lab, while delineating his/her own contribution
6) manage time (and other resources) effectively, setting and meeting deadlines
7) maintain a lab notebook to record, organize, evaluate and interpret data
8) apply problem-solving to constructively address research setbacks, identifying lessons learned and ways to improve
9) practice research ethics and responsible conduct in the lab environment
10) explain learning objectives and research results to others using various modes (written reports, progress updates, Powerpoint presentations, proposals, …)
11) infer the relevance of research experience to his/her coursework at Hopkins and professional future

The faculty advisor, in connection with the student, will determine which of the above objectives will apply to each enrollment and the assessment mechanisms (see below) that will be used.

ASSESSMENT

- Work for the designated amount of time each week in the lab/team, commensurate with the credits assigned to your “research for credit” course. On average, it will require a minimum of 10 hours per week in the laboratory to earn 3 credits in a semester.
- Participate in weekly or bi-weekly lab/team meetings.
- Show your faculty advisor your lab notes and progress reports, periodically during the semester.
- Around the end of the semester, submit to your supervisor a one-page summary or a Powerpoint presentation, or another form of document that summarizes the objectives that have been met (e.g., the materials science question you have addressed, the methods you have used, and your role in the project …). This written summary needs to be approved by your supervisor before you receive the credits, and a copy with this approval signature should be filed with Ms. Jeanine Majewski to be kept in the “Research for credits in MSE” record maintained by the MSE Department.

MATERIALS SCIENCE & ENGINEERING
SELECTED UNDERGRADUATE PROGRAM COURSE DESCRIPTIONS

510.106 (E, N) Foundations of Materials Science and Engineering (3 credits, Fall)
Basic principles of materials science and engineering and how they apply to the behavior of materials in the solid state. The relationship between electronic structure, chemical bonding, and crystal structure is developed. Attention is given to characterization of atomic and molecular arrangements in crystalline and amorphous solids: metals, ceramics, semiconductors and polymers (including proteins). The processing and synthesis of these different categories of materials. Basics about the phase diagrams of alloys and mass transport in phase transformations. Introduction to materials behavior including their mechanical, chemical, electronic, magnetic, optical and biological properties.

510.107 (E, N) Modern Alchemy (3 credits, Spring)
Can you really turn lead into gold? Converting common substances into useful materials that play important roles in today's technologies is the goal of many modern scientists and engineers. In this course, we will survey selected topics related to modern materials, the processes that are used to make them as well as the inspiration that led to their development. Topics will include the saga of electronic paper, the sticky stuff of gecko feet and the stretchy truth of metal rubber.

The following course series, 510.311-316 + Labs 510.428-429 + Senior Design 510.433-434 (or their variations for the bio- and nano- concentrations), is devoted to the fundamental principles and engineering applications of materials and the concepts necessary for the design of materials systems. This series is required for all majors in Materials Science and Engineering.

510.311 (E,N) Structure of Materials (3 credits, Fall)
First of the Introduction to Materials Science series, this course is devoted to study of the structure of materials. Lecture topics include bonding, atomic packing, crystal structure, imperfections in crystals, noncrystalline solids, and composite materials. Among the techniques treated are X-ray diffraction, stereographic projection, and optical and electron microscopy. **Prerequisites: Calculus I, freshman/sophomore chemistry and physics, or permission of instructor.**

510.312 (E,N) Physical Chemistry of Materials I: Thermodynamics (3 credits, Spring)
Second of the Introduction to Materials Science series, this course examines the principles of thermo-dynamics as they apply to materials. Topics include fundamental principles of thermodynamics, equilibrium in homogeneous and heterogeneous systems, thermodynamics of multicomponent systems, phase diagrams, thermodynamics of defects, and elementary statistical thermodynamics. **Prerequisites: Calculus I and II, freshman/sophomore chemistry and physics, or permission of instructor.**

510.313 (E,N) Mechanical Properties of Materials (3 credits, Fall)
Third of the Introduction to Materials Science series, this course is devoted to a study of the mechanical properties of materials. Lecture topics include elasticity, anelasticity, plasticity, and fracture. The concept of dislocations and their interaction with other lattice defects is introduced. Among the materials studied are metals, polymers, ceramics, glasses, and composites. **Prerequisite: 510.311**.

510.314 (E,N) Electronic Properties of Materials (3 credits, Spring)
Fourth of the Introduction to Materials Science series, this course is devoted to a study of the electronic, optical and magnetic properties of materials. Lecture topics include electrical and thermal conductivity, thermoelectricity, transport phenomena, dielectric effects, piezoelectricity, and magnetic phenomena. **Prerequisite: 510.311 or permission of instructor**

510.315 (E,N) Physical Chemistry of Materials II: Kinetics and Phase Transformations (3 credits, Fall)
Fifth of the Introduction to Materials Science series, this course covers diffusion and phase transformations in materials. Topics include Fick's laws of diffusion, atomic theory of diffusion, diffusion in multicomponent systems, solidification, diffusional and diffusionless transformations, and interfacial phenomena. **Prerequisite: 510.312**.

510.316 (E,N) Biomaterials I (3 credits, Spring)
Sixth of the Introduction to Materials Science series, this course offers an overview of principles and properties of biomedical materials. Topics include properties of materials used in medicine, synthesis and properties of polymeric materials, polymeric biomaterials, natural and recombinant biomaterials, biodegradable materials, hydrogels, stimuli-sensitive materials, and characterizations of biomaterials. **Prerequisites: 030.205 Organic Chemistry I.**

510.428 (E,N,W) Materials Science Laboratory I (3 credits, Fall)
This course focuses on characterizing the microstructure and mechanical properties of structural materials that are commonly used in modern technology. A group of A1 alloys, Ti alloys, carbon and alloy steels, and composite materials that are found, for example, in actual bicycles will be selected for examination. Their microstructures will be studied using optical metallography, scanning electron microscopy, X-ray diffraction, and transmission electron microscopy. The mechanical properties of these same materials will be characterized using tension, compression, impact, and hardness tests. The critical ability to vary microstructure and therefore properties through mechanical and heat treatments will also be demonstrated and investigated in the above materials. **Pre- or co-requisites: 510.311 & 510.313**

510.429 (E,N,W) Materials Science Laboratory II (3 credits, Spring)
This laboratory concentrates on the experimental investigation of electronic properties of materials using basic measurement techniques. Topics include thermal conductivity of metal alloys, electrical conductivity of metals/metal alloys and semiconductors, electronic behavior at infrared wavelengths, magnetic behavior of materials, carrier mobility in semiconductors and the Hall effect in metals and semiconductors. Additional topics considered include basic processing of electronic materials and electronic device construction. Prerequisite: 510.311 or permission of instructor. **Pre- or co-requisites: 510.311 & 510.314**

510.433 (E,N,W) Senior Design/Research Experience in Materials Science & Engineering I (3 credits, Fall)
This course is the first half of a two-semester sequence required for seniors majoring or double majoring in materials science and engineering. It is intended to provide a broad exposure to many aspects of planning and conducting independent research. During this semester, students join ongoing graduate research projects for a typical 10-12 hours per week of hands-on research. Classroom activities include discussions, followed by writing of research pre-proposals (white

papers), proposals, status reports and lecture critiques of the weekly departmental research seminar. **Prerequisites: 510.311-312, 510.428-429.**

510.434 (E,N,W) Senior Design/Research Experience in Materials Science and Engineering II (3 credits, Spring)
This course is the second half of a two-semester sequence required for seniors majoring or double majoring in materials science and engineering. It is intended to provide a broad exposure to many aspects of planning and conducting independent research. During this semester, verbal reporting of project activities and status is emphasized, culminating in student talks presented to a special session of students and faculty. Written final reports describing the research projects provide lasting mementos of this course. **Prerequisites: 510.311-312, 510.428-429.**

510.438 (E,N,W) Biomaterials Senior Design I (3 credits, Fall)
This course is the first half of a two-semester sequence required for seniors majoring in materials science and engineering with the biomaterials concentration. It is intended to provide a broad exposure to many aspects of planning and conducting independent biomaterials research. During this semester, students join ongoing graduate research projects for a typical 10-12 hours per week of hands-on experiences in design and research. Classroom activities include discussions, followed by writing of research pre-proposals (white papers), proposals, status reports and lecture critiques of the weekly departmental research seminar. **Prerequisites: 510.311-312, 510.428-429.**

510.439 (E,N,W) Biomaterials Senior Design II (3 credits, Spring)
This course is the second half of a two-semester sequence required for seniors majoring in materials science and engineering with the biomaterials concentration. It is intended to provide a broad exposure to many aspects of planning and conducting independent biomaterials research. During this semester, verbal reporting of project activities and status is emphasized, culminating in student talks presented to a special session of students and faculty. Students also prepare a poster and written final report summarizing their design and research results. **Prerequisites: 510.311-312, 510.428-429.**

510.440 (E,W) Nanomaterials Senior Design I (3 credits, Fall)
This course is the first half of a two-semester sequence required for seniors majoring in materials science and engineering with the nanotechnology concentration. It is intended to provide a broad exposure to many aspects of planning and conducting independent nanomaterials research. During this semester, students join ongoing graduate research projects for a typical 10-12 hours per week of hands-on experiences in design and research. Classroom activities include discussions, followed by writing of research pre-proposals (white papers), proposals, status reports and lecture critiques of the weekly departmental research seminar. **Prerequisites: 510.311-312, 510.428-429.**

510.441 (E,W) Nanomaterials Senior Design II (3 credits, Spring)
This course is the second half of a two-semester sequence required for seniors majoring in materials science and engineering with the nanotechnology concentration. It is intended to provide a broad exposure to many aspects of planning and conducting independent nanomaterials research. During this semester, verbal reporting of project activities and status is emphasized, culminating in student talks presented to a special session of students and faculty. Students also prepare a poster and written final report summarizing their design and research results.

Prerequisites: 510.311-312, 510.428-429.

Upper Level Materials Science and Engineering Undergraduate Electives.

Not all electives are offered each academic year.

510.400 (E,N) Introduction to Ceramics (3 credits, Spring)
This course will examine the fundamental structure and property relationships in ceramic materials. Areas to be studied include the chemistry and structure of ceramics and glasses, microstructure and property relationships, ceramic phase relationships, and ceramic properties.
Particular emphasis will be placed on the physical chemistry of particulate systems, characterization, and the surface and colloid chemistry of ceramics. **Prerequisites: 510.311, 510.312 or permission of the instructor.**

510.403 (E, N) Materials Characterization (3 credits, Fall)
This course will describe a variety of techniques used to characterize the structure and composition of engineering materials, including metals, ceramics, polymers, composites, and semiconductors. The emphasis will be on microstructural characterization techniques, including optical and electron microscopy, x-ray diffraction, and acoustic microscopy. Surface analytical techniques, including Auger electron spectroscopy, secondary ion mass spectroscopy, x-ray photoelectron spectroscopy, and Rutherford backscattering spectroscopy. Real-world examples of materials characterization will be presented throughout the course, including characterization of thin films, surfaces, interfaces, and single crystals.

510.405 (E, N) Energy Engineering: Fundamentals and Future (3 credits)
This course examines the science and engineering of contemporary and cutting-edge energy technologies. Materials Science and Mechanical Engineering fundamentals in this area will be complemented by case studies that include fuel cells, solar cells, lighting, thermoelectrics, wind turbines, engines, nuclear power, biofuels, and catalysis. Students will consider various alternative energy systems, and also to research and engineering of traditional energy technologies aimed at increased efficiency, conservation, and sustainability. Prerequisite: undergraduate course in thermodynamics

510.407 (E, N) Biomaterials II (3 credits, Fall)
This course focuses on the interaction of biomaterials with the biological system and applications of biomaterials. Topics include host reactions to biomaterials and their evaluation, cell-biomaterials interaction, biomaterials for tissue engineering applications, biomaterials for controlled drug and gene delivery, biomaterials for cardiovascular applications, biomaterials for orthopedic applications, and biomaterials for artificial organs. **Prerequisites: 510.316**

510.408 (E, N) Simulation of Materials & Biological Systems (3 credits, Spring)
This course will review basics of programming in MATLAB environment. Students will build their MATLAB skills by programming assignments regarding a range of biological and materials systems. Integration of time-dependent ODEs and PDEs, solution of eigenvalue problems, Monte Carlo calculations and molecular dynamics simulations will be explored in the context of problems that may include chemical reactions, band structure, phase equilibrium, disease progression, waves in heart tissue, glycolysis, and other relevant scientific and engineering applications.

510.409 (E, N) Melting, Smelting, Refining and Casting (3 credits)
This is a laboratory class on metal formation, an area that underlies almost all other technologies. We will examine extraction of metals from ore, refining of metals. The kinetics of melting and solidification will be explored in the context of casting and forming.

510.415 (E, N) The Chemistry of Materials Synthesis (3 credits)
Many of the latest breakthroughs in materials science and engineering have been driven by new approaches to their synthesis, which has allowed the preparation of materials with fanciful structures and fascinating properties. This advanced course will explore synthetic approaches to multifunctional and nanostructured materials, ranging from opals to complex polymers to nanowires and quantum dots . Applications include electronics, energetics, and drug delivery. Participants will gain sufficient familiarity with synthesis options to be able to design research programs that rely on them. Emphasis will be placed on broad strategies that lead to material functionality, rather than detailed step-by-step sequences. Some topics will be selected "on the fly" from the most exciting current literature. Prerequisites: 030.205 Organic Chemistry I, and 510.312 or equivalent thermodynamics course.

510.416 (E, N) Applications of X-Ray Diffraction (3 credits)
Practical aspects of structural characterization with x-ray diffraction. Topics include orientation of single crystals; lattice parameter measurement; phase identification; quantitative phase analysis; crystallographic texture determination; stress measurement; diffraction from long-period structures including superlattices, multilayers, and layered molecular solids; and scattering from liquids and amorphous solids. The course will combine lectures with several laboratory exercises intended to give students experience in data collection and analysis for a variety of diffraction techniques.

510.419 (E, N) Physical Metallurgy (3 credits)
This course examines the relationship between microstructure and mechanical properties of metals and alloys. Starting from fundamentals (phase diagrams and phase transformation kinetics), we will explore how the structure of metals and alloys can be manipulated by thermomechanical processing to achieve desired properties. Detailed examples will be drawn from several alloy systems, including steels, aluminum, and titanium. A theme of the course will be the impact of materials processing and materials selection on the environment, including considerations of lightweight materials and processing techniques for minimizing energy consumption. **Prerequisites: 510.311-312, 510.314-315.**

510.422 (E, N) Micro- and Nano-Structured Materials and Devices (3 credits, Spring)
Almost every materials property changes with scale. We will examine ways to make micro- and nano-structured materials and discuss their mechanical, electrical, and chemical properties. Topics include the physics and chemistry of physical vapor deposition, thin film patterning, and microstructural characterization. Particular attention will be paid to current technologies including computer chips and memory, thin film sensors, diffusion barriers, protective coatings, and microelectromechanical devices (MEMS). **Prerequisites: 510.311, 510.312, 510.315**.

510.423 (E, N) Mechanical Properties of Thin Films and Nanostructured Materials
(3 credits, Spring)

The mechanical properties of thin films on substrates and nanomaterials will be discussed. Topics include: elastic, plastic, and diffusional deformation of thin films and nanomaterals; effects of temperature, microstructure, and capillarity on mechanical behavior; mechanical characterization techniques; mechanics of thin film stresses that develop during thin film growth; experimental methods for measuring thin film stresses; thin film adhesion; strengthening processes in nanomaterials. Prerequisite: 510.313 or equivalent

510.426 (E, N) Biomolecular Materials I (3 credits, Fall)
Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Structure and function of molecular machines (enzymes for biosynthesis, motors, pumps). Protein synthesis using recombinant nucleic acid methods. Advanced materials development. Interactions of biopolymers, lipid membranes, and their complexes. Mean field theories, fluctuation and correlation effects. Self assembly in biomolecular materials. Biomedical applications. Characterization techniques.

510.430 (E,N) Biomaterials Lab (3 credits, Spring)
This laboratory course concentrates on synthesis, processing and characterization of materials for biomedical applications, and characterization of cell-materials interaction. Topics include synthesis of biodegradable polymers and degradation, electrospinning of polymer nanofibers, preparation of polymeric microspheres and drug release, preparation of plasmid DNA, polymer-mediated gene delivery, recombinant protein synthesis and purification, self-assembly of collagen fibril, surface functionalization of biomaterials, cell culture techniques, polymer substrates for cell culture, and mechanical properties of biological materials. **Pre- or co-requisite: 510.407.**

510.435 (E, N) Mechanical Properties of Biomaterials (3 credits)
This course will focus on the mechanical properties of biomaterials and the dependence of these properties on the microstructure of the materials. Organic and inorganic systems will be considered through a combination of lectures and readings and the material systems will range from cells to bones to artificial implants.

510.442 (E,W) Nanomaterials Lab (3 credits, Fall)
The objective of the laboratory course will be to give students hands on experience in nanotechnology based device fabrication through synthesis, patterning, and characterization of nanoscale materials. The students will use the knowledge gained from the specific synthesis, characterization and patterning labs to design and fabricate a working nanoscale/nanostructured device. The course will be augmented with comparisons to microscale materials and technologies. These comparisons will be key in understanding the unique phenomena that enable novel applications at the nanoscale.
DMSE Seniors or permission of the instructor.

510.443 (E, N) Chemistry and Physics of Polymers (3 credits, Fall)
The course will describe and evaluate the synthetic routes, including condensation and addition polymerization, to macromolecules with varied constituents and properties. Factors that affect the efficiencies of the syntheses will be discussed. Properties of polymers that lead to technological applications will be covered, and the physical basis for these properties will be derived. Connections to mechanical, electronic, photonic, and biological applications will be made.
Prerequisites: Organic Chemistry I and one semester of thermodynamics

510.457 (E, N) Materials Science of Thin Films (3 credits)
The processing, structure, and properties of thin films are discussed emphasizing current areas of scientific and technological interest. Topics include elements of vacuum science and technology; chemical and physical vapor deposition processes; film growth and microstructure; chemical and microstructural characterization methods; epitaxy; mechanical properties such as internal stresses, adhesion, and strength; and technological applications such as superlattices, diffusion barriers, and protective coatings.

510.501-502 (E, N) Research in Materials Science and Engineering (1-3 credits)
Student participation in ongoing research activities. Research is conducted under the supervision of a faculty member and often in conjunction with other members of the research group.

510.503-504 (E, N) Independent Study in Materials Science and Engineering (1-3 credits)
Individual programs of study are worked out between students and the professor supervising their independent study project. Topics selected are those not formally listed as regular courses and include a considerable design component. **Prerequisite: permission of instructor.**

510.597 (E, N) Summer Independent Research in Materials Science and Engineering
(1-3 credits)

510.599 (E, N) Summer Independent Study in Materials Science and Engineering
(1-3 credits)

ACADEMIC ETHICS

The strength of the university depends on the integrity of those who engage in its mission. Ethical behavior results in trust providing an atmosphere in which the open and free exchange of ideas can occur. Trust allows us to come together, helping each of us reach levels that we could never achieve alone. The absence of ethical and considerate behavior engenders mistrust among the members of the university community and erodes the quality discourse. It divides us and ultimately degrades what we know and who we are.

The Department of Materials Science and Engineering strives to uphold the ideals of academic integrity and seeks to create an atmosphere in which all members of the Department display the highest degree of ethical conduct. Creating this atmosphere is the responsibility of all members of the Department – students, faculty and staff – and can only be achieved with the consistent education of its members about the standards of academic honesty and ethical behavior.

Briefly, acts of academic dishonesty include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. University approved procedures for addressing academic ethics violations are published in the Undergraduate Academic Ethics Board Constitution (http://e-catalog.jhu.edu/undergrad-students/student-life-policies/#UAEB). Students accused of academic dishonesty are encouraged to consult the Ethics Board Constitution as well as with the Dean of Student Life in Office of Homewood Student Affairs. More information on academic ethics at Johns Hopkins is available, at https://studentaffairs.jhu.edu/student-life/student-conduct/academic-ethics-undergraduates/ and at https://studentaffairs.jhu.edu/student-life/student-conduct/resources-conduct-ethics/.

Office of the Dean of Student Life
Mattin Center
Offit Building Suite 210
The Johns Hopkins University
3400 N. Charles St.
Baltimore, Md. 21218

Voice: 410-516-8208

COUNSELING RESOURCES

Making the transition to the university can be difficult and the pressures of coursework, relationships and career decisions can be overwhelming. You are not alone. While your roommate, your friends or your advisor might be able to help you get through difficult times, there are problems that you might face that are best addressed by seeking out counselors who can best guide and advise you on how to handle them. There are trained professional counselors available in the Counseling Center (https://studentaffairs.jhu.edu/counselingcenter/) who can confidentially assist you in addressing your problems. Staffed by professional psychologists and consulting psychiatrists, the Counseling Center offers counseling services that are free and confidential, as prescribed by law. Typical concerns may include test anxiety and academic performance, relationship issues, family problems, career concerns, stress, general unhappiness, self-confidence, as well as many other concerns. There also exists a confidential peer-counseling program (A Place to Talk – APTT, http://pages.jh.edu/~aptt/about.html) staffed by undergraduate students who are familiar with the pressures of undergraduate life at Hopkins and can assist students with those common problems that all undergraduates face during their time here.

The Counseling Center
3003 N Charles St
Homewood Apartments
Suite S-200
Baltimore, MD 21218

https://studentaffairs.jhu.edu/counselingcenter/
also see
https://studentaffairs.jhu.edu/counselingcenter/additional-resources/

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