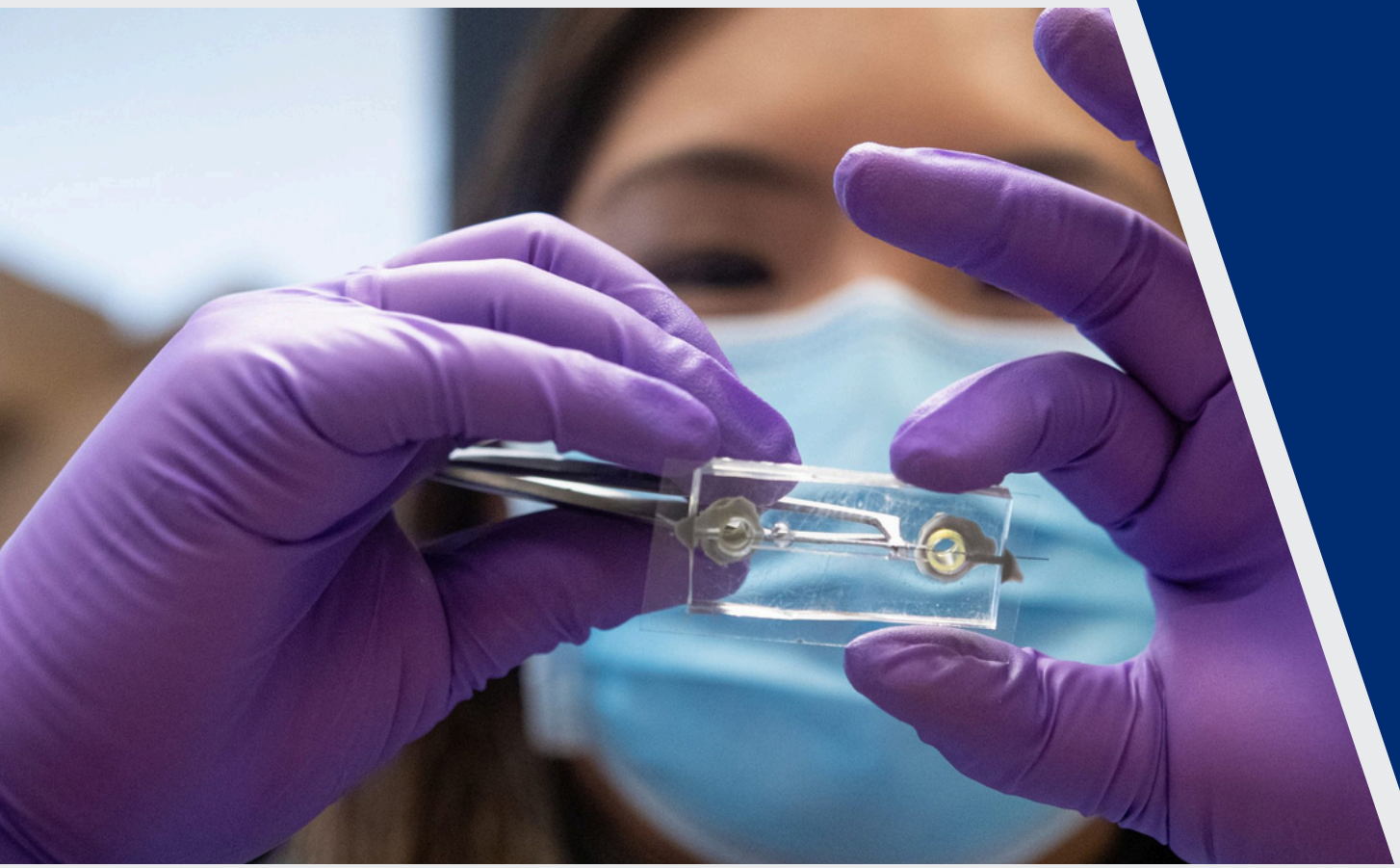
Undergraduate **Program of Study**



Department of Materials Science & Engineering

2024/2025

Sample Undergraduate Programs for Materials Science and Engineering: Standard Track

Standard Track **(for a student beginning with Calculus I)**

First Year Fall		
030.101	Introductory Chemistry I	3
030.105	Intro. Chem. Lab I	1
110.108	Calculus I	4
510.106	Foundations of Materials Science & Engineering*	3
	First Year Seminar	2-3
	Unrestricted Elective	3
Total		16-17

*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
171.101	General Physics I or 171.107 General Physics for Physical Sciences Majors (AL)	4
173.111	General Physics Lab I	1
110.109	Calculus II	4
500.113	Gateway Computing –Python	3
Total		16

Second Year Fall		
510.311	**Structure of Materials**	**3**
030.205	Intro. Organic Chem. I	4
171.102	General Physics II or 171.108 General Physics for Physical Sciences Majors (AL),	4
173.112	General Physics Lab II	1
110.202	Calculus III	4
Total		16

Second Year Spring		
510.312	**Physical Chemistry of Materials. I: Thermodynamics**	**3**
510.316	**Foundations of Biomaterials**	**3**
553.291	Linear Algebra and Differential Equations	4
	Humanities/Social Science elective	3
	Humanities/Social Science elective	3
Total		16

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**
553.311	Intermediate Probability and Statistics	4
	Unrestricted elective	3
Total		16

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

*Writing Intensive (W)

Fourth Year Fall		
510.433	**Senior Design I**	**3**
510.4##	**MSE elective**	**3**
510.4##	**MSE elective**	**3**
	Math/Sci/Eng elective	3
660.463	Engineering Management and Leadership	3
		15

Fourth Year Spring		
510.434	**Senior Design II**	**3**
510.4##	**MSE elective**	**3**
510.4##	**MSE elective**	**3**
	Humanities/Social Science elective	3
	Humanities/Social Science elective	3
Total		15
Grand Total		**125-126**

Sample Undergraduate Programs for Materials Science and Engineering: Biomaterials Concentration

Biomaterials Concentration **(for a student beginning with Calculus I)**

First Year Fall		
030.101	Introductory Chemistry I	3
030.105	Intro. Chem. Lab I	1
110.108	Calculus I	4
510.106	Foundations of Materials Science & Engineering*	3
	First Year Seminar	2-3
	Unrestricted Elective	3
Total		16-17

*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
110.109	Calculus II	4
171.101	General Physics I or 171.107 General Physics for Physical Sciences Majors (AL)	4
173.111	General Physics Lab I	1
500.113	Gateway Computing - Python	3
Total		16

Second Year Fall		
510.311	**Structure of Materials**	**3**
110.202	Calculus III	4
171.102	General Physics II or 171.108 General Physics for Physical Science Majors (AL),	4
173.112	General Physics Lab II	1
030.205	Intro. Organic Chem. I	4
Total		16

Second Year Spring		
510.312	**Physical Chemistry of Materials. I: Thermodynamics**	**3**
510.316	**Foundations of Biomaterials**	**3**
553.291	Linear Algebra and Differential Equations	4
	Humanities/Social Science electives	3
	Humanities/Social Science electives	3

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**
580.221	Biochemistry and Molecular Engineering**	4
	Unrestricted elective	3
Total		16

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

Third Year Spring		
510.314	**Electronic Properties of Materials**	**3**
510.429	**Materials Science Lab II***	**3**
553.311	Intermediate Probability and Statistics	4
	Humanities/ Social Science elective	3
	Math/Sci/Eng elective	3
Total		16

*Writing Intensive (W)

Fourth Year Fall		
510.438	**Biomaterials Senior Design I**	**3**
510.4##	**MSE elective (Biomolecular Materials)**	**3**
510.4##	**MSE elective**	**3**
660.463	Engineering Management and Leadership	**3**
	Humanities/Social Science elective	3
Total		15

Fourth Year Spring		
510.439	**Biomaterials Senior Design II**	**3**
510.4##	**MSE elective**	**3**
510.430	**Biomaterials Lab**	3
2 courses	Humanities/Social Science elective	6 credits total
Total		15
Grand Total		**126-127**

Students pursuing the Biomaterials Concentration will complete a total of 126-127 credits instead of 125-126 credits.

Sample Undergraduate Programs for Materials Science and Engineering: Nanotechnology Concentration

Nanotechnology Concentration **(for a student beginning with Calculus I)**

First Year Fall		
030.101	Introductory Chemistry I	3
030.105	Intro. Chem. Lab I	1
110.108	Calculus I	4
510.106	Foundations of Materials Science & Engineering*	3
	First Year Seminar	2-3
	Unrestricted elective	3
Total		16-17

*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
110.109	Calculus II	4
171.101	General Physics I or 171.107 General Physics for Physical Sciences Majors (AL),	4
173.111	General Physics Lab I	1
500.113	Gateway Computing - Python	3
Total		16

Second Year Fall		
510.311	**Structure of Materials**	**3**
030.205	Intro. Organic Chem. I	4
110.202	Calculus III	4
171.102	General Physics II or 171.108 General Physics for Physical Sciences Majors (AL)	4
173.112	General Physics Lab II	1
Total		16

Second Year Spring		
510.312	**Physical Chemistry of Materials. I: Thermodynamics**	**3**
510.316	**Foundations of Biomaterials**	**3**
553.291	Linear Algebra and Differential Equations	4
	Humanities/Social Science elective	3
	Humanities/Social Science elective	3
Total		16

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**
	Math/Sci/Eg elective**	3
	Unrestricted elective	3
Total		15

Third Year Spring		
510.314	**Electronic Properties of Materials**	**3**
510.429	**Materials Science Lab II***	**3**
553.311	Intermediate Probability and Statistics	4
	Humanities/Social Science elective	3
	Math/Sci/Eng elective	3
Total		16

*Writing Intensive (W)

**For some students, a possible choice is 560.201

Fourth Year Fall		
510.440	**Nanomaterials Senior Design I**	**3**
510.442	**Nanomaterials Lab**	**3**
510.4##	**MSE elective (Materials Characterization)**	**3**
660.463	Engineering Management and Leadership	3
	Humanities/Social Science elective	3
Total		15

Fourth Year Spring		
510.441	**Nanomaterials Senior Design II**	**3**
510.4##	**MSE elective (Micro Nano Mater. Devices)**	**3**
510.4##	**MSE elective**	**3**
	Humanities/Social Science elective	3
	Humanities/Social Science elective	3
Total		15
Grand Total		**125-126**

Students are encouraged to take EN.510.106 Foundations of Materials Science & Engineering and count it as an unrestricted elective.

Students beginning at the Calculus I level should discuss when to take Physics I and lab with an academic advisor.

Requirement Check List (& sign-off sheet) for B.S in MSE

To be filled in by students before meeting with your advisor each semester. For open electives, fill in the line with the class used to satisfy the requirement (the same course cannot be used to fulfill more than one requirement). This form can also be used as the sign-off sheet for graduation. To petition for waiver/substitution of a course, a separate form is available on MSE department website.

Student's Name_____ Advisor's Name_____Date_____

MATERIALS SCIENCE CORE CLASSES

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

Course #	Course name	Instructor	Semester	Credits	Grade
510.311	Structure of Materials			3	
510.312	Phys. Chem. I: Thermodynamics			3	
510.313	Mechanical Properties			3	
510.314	Electronic Properties			3	
510.315	Phys. Chem. II: Kinetics			3	
510.316	Foundations of Biomaterials			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	
Total				30	

- *Senior design has 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

Course #	Course name	Instructor	Semester	Credits	Grade
Total				12	

- *Independent research can only count toward three (3) credits of this requirement.*
- *Biomaterials/ Nanotechnology Concentration requires 9 credits plus Lab focused on Bio/Nano. 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

Course #	Course name	Instructor	Semester	Credits	Grade
171.101	General Physics II or 171.107 General Physics for Physical Science Majors (AL)			4	
171.102	General Physics II or 171.108 General Physics for Physical Science Majors (AL)			4	
173.111	General Physics I Lab			1	
173.112	General Physics II Lab			1	
030.101	Intro Chem I			3	
030.102	Intro Chem II			3	
030.105	Intro Chem Lab I			1	
030.106	Intro. Chem Lab II			1	
030.205	Intro. Organic Chemistry I			4	
500.113	Gateway Computing - Python			3	
660.463	Engineering Management & Leadership			3	
Total				28	

MATHEMATICS

- Letter grade of C- or higher
- 20 credits

Course #	Course name	Instructor	Semester	Credits	Grade
110.108	Calculus I			4	
110.109	Calculus II			4	
110.202	Calculus III			4	
553.291	Linear Algebra & Differential Equations			4	
553.311	Probability & Statistics for the Biological Sciences & Eng.			4	
Total				20	

HUMANITIES (H OR S)

- Letter grade of C- or higher required if taken for letter grade; S required if taken S/U
- 18 credits; 3-credit courses only (WSE requirement)

Course #	Course name	Instructor	Semester	Credits	Grade
Total				18	

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

First-Year Seminar (FYS)

- All students entering Hopkins from high school are required to complete a First-Year Seminar with a Satisfactory (S) grade in their first year of study. First-Year Seminars are offered only with the Satisfactory/Unsatisfactory grading system; they are not offered for letter grades.

Course #	Course name	Instructor	Semester	Credits	Grade
Total				2-3	

General Mathematics, Science and Engineering Electives

- Two courses of 200- level or above in engineering, natural sciences or mathematics
- 6 credits
- Letter grade of C- or higher required if taken for letter grade; S required if taken S/U
- At least one of the three electives must be from another department in WSE (to ensure the exposure to another engineering field)

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Course #	Course name	Instructor	Semester	Credits	Grade	WSE Dept.
Total				6		

- *For Biomaterials Concentration, one of these must be 580.221* Biochemistry and Molecular Engineering *(4 credits). Students can substitute with Cell Bio + Biochem., ask your advisor to check* Approved alternatives for some MSE required courses.
- *For other students, a possible choice is 560.201 + 560.211(Lab) Statics and Mechanics (3+1=4 credits).*

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

Course #	Course name	Instructor	Semester	Credits	Grade
Total				9	

- A student who has taken 510.106 Foundations of MSE may count it toward one unrestricted elective.

Total Number of Required Credits **125**
(**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, see Minutes of Faculty Meeting, Dec. 4, 2017.

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 sheet should be updated each semester by the student's faculty advisor. Certification is required for graduation:

Certification by Faculty Advisor:

Name_____ Signature_____ Date_____

Certification by Chair of Undergraduate Program Committee:

Name_____ Signature_____ Date_____

Click here to view approved electives

APROVED ALTERNATIVES FOR SOME MSE REQUIRED COURSES

Listed in the following are some courses on Homewood campus that the MSE department has approved a priori as choices for satisfying the MSE requirements. These are alternatives that each has a title very similar, or a content roughly equivalent, to the courses we require, such that a separate substitution/waiver form is not necessary (although you may choose to keep one for your record). In other words, the student and his/her faculty advisor can simply fill the slot in the check/sign-off list with one of these pre-approved choices.

To use other relevant courses as substitution, i.e., candidate classes that are not equivalent to our courses, you need to obtain permission from the faculty advisor and UG Committee using the Substitution/Waiver form.

BASIC SCIENCES AND ENGINEERING
Letter grade of C- or higher
28 total credits

Course #	Course name and credits	Alternative	Dept.	Credits to receive	Notes
171.101	General Physics I (4)				
171.102	General Physics II (4)				
173.111	General Physics I Lab (1)				
173.112	General Physics II Lab (1)				
030.101	Intro Chem I (3)				
030.102	Intro Chem II (3)				
030.105	Intro Chem Lab I (1)				
030.106	Intro. Chem Lab II (1)				
030.205	Intro. Organic Chemistry I (4)				
500.113	Gateway Computing (3)	510.112 GC Java + 500.113 Python bootcamp	WSE	3+1	

MATHEMATICS

- Letter grade of C- or higher
- 20 total credits

Course #	Course name & credits	Alternative	From dept.	Credits to receive	Notes
110.108	Calculus I (4)				
110.109	Calculus II (4)				
110.202	Calculus III (4)				
553.291	Linear Algebra & Differential Equations (4)	110.201 or 110.202 LA (4) + 110.302 DE (4) i.e., take two separate from Math, not the combined one from Appl Math	Math	4+4	Use excess credits for General Math elective
553.311	553. 311 Probability and Statistics for the Biological Sciences and Engineering (4)	560.348 Probability & Statistics for Engineers (3)	Civil	3	Need to find one more Math credit

GENERAL MATHEMATICS, SCIENCE AND ENGINEERING ELECTIVES

- Three courses of 200-level or above in engineering, natural sciences or mathematics
- 9 credits
- At least one of the three electives must be from another department in WSE

Course #	Course name & credits	Alternative	From dept.	Credits	Notes	WSE Dept.
580.221	Biochemistry and Molecular Engineering (4), required for Biomater. track	AS.020.306 Cell Biology (4) + AS.020.305 Biochemistry (4) or EN.540.307 Cell Biology for Engineers (3) + AS.020.305 Biochemistry (4)	Biology ChemBE + Biology	4+4 3+4	use the excess credits to satisfy General Science elective	No. They are from Krieger Yes, the first one is from WSE

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:

- Articulate a materials research question, with a working hypothesis
- Execute a literature search related to the topic selected with a clear explanation how the project fills a knowledge gap
- Communicate confidently and effectively with mentors and team mates
- Identify appropriate research methodologies and lab skills/tools, and use them for the project chosen
- Work collaboratively with other researchers in the lab, while delineating his/her own contribution
- Manage time (and other resources) effectively, setting and meeting deadlines
- Maintain a lab notebook to record, organize, evaluate and interpret data
- Apply problem-solving to constructively address research setbacks, identifying lessons learned and ways to improve
- Practice research ethics and responsible conduct in the lab environment
- Explain learning objectives and research results to others using various modes (written reports, progress updates, PowerPoint presentations, proposals, …)
- 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 Mrs. Lauren Rodgers to be kept in the "Research for credits in MSE" record maintained by DMSE.

MATERIALS SCIENCE & ENGINEERING SELECTED UNDERGRADUATE PROGRAM COURSE DESCRIPTIONS

510.106 (E, N) Foundations of Materials Science and Engineering. 3 Credits.
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.

EN.510.135. MSE Design Team I. 3 Credits.
This course is the first half of a two-semester course sequence for freshmen majoring or double majoring in materials science and engineering (MSE). This course provides a broad exposure to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE freshmen working with a team leader and seniors on the team, apply their general knowledge in MSE to develop the solution to open-ended problems. Materials Science & Engineering Freshman Only. Recommended Course Background: EN.510.106, EN.510.109, or equivalent courses. *The team will meet 150 minutes per week at a time to be designated by the instructor.
Distribution Area: Engineering, Natural Sciences

EN.510.136. MSE Design Team I. 3 Credits.
This course is the second half of a two-semester course sequence for freshmen majoring or double majoring in materials science and engineering (MSE). This course provides a broad exposure to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE freshmen working with a team leader and seniors on the team, apply their general knowledge in MSE to develop the solution to open-ended problems. Materials Science & Engineering Freshman Only. Recommended Course Background: EN.510.106, EN.510.109, or equivalent courses. *The team will meet 150 minutes per week at a time to be designated by the instructor.
Distribution Area: Engineering, Natural Sciences

EN.510.235. MSE Design Team I. 3 Credits.
This course is the first half of a two-semester course sequence for sophomores majoring or double majoring in materials science and engineering (MSE). This course provides a broad exposure to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE freshmen working with a team leader and seniors on the team, apply their general knowledge in MSE to develop the solution to open-ended problems. Materials Science & Engineering Sophomores Only. Recommended Course Background: EN.510.106, EN.510.109, or equivalent courses. *The team will meet 150 minutes per week at a time to be designated by the instructor.

EN.510.236. MSE Design Team I. 3 Credits.
This course is the second half of a two-semester course sequence for sophomores majoring or double majoring in materials science and engineering (MSE). This course provides a broad exposure to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE freshmen working with a team leader and seniors on the team, apply their general knowledge in MSE to develop the solution to open-ended problems. Materials Science & Engineering Sophomores Only. Recommended Course Background: EN.510.106, EN.510.109, or equivalent courses. *The team will meet 150 minutes per week at a time to be designated by the instructor.
Distribution Area: Engineering, Natural Sciences

EN.510.311. Structure Of Materials. 3 Credits.
First of the Introduction to Materials Science series, this course seeks to develop an understanding of the structure of materials starting at the atomic scale and building up to macroscopic structures. Topics include bonding, crystal structures, crystalline defects, symmetry and crystallography, microstructure, liquids and amorphous solids, diffraction, molecular solids and polymers, liquid crystals, amphiphilic materials, and colloids. This course contains computational modules; some prior knowledge of computer programming is needed.
Prerequisite(s): ((AS.110.106 AND AS.110.107) OR (AS.110.108 AND AS.110.109) OR (AS.110.107 AND AS.110.108) OR (AS.110.106 OR AS.110.109)) AND (AS.030.103 OR(AS.030.101 AND AS.030.102)) AND ((AS.171.101 OR AS.171.103 OR AS.171.107) AND (AS.171.102 OR AS.171.104 OR AS.171.108));EN.500.113
Distribution Area: Engineering, Natural Sciences

EN.510.312. Thermodynamics/Materials. 3 Credits.
Second of the Introduction to Materials Science series, this course examines the principles of thermodynamics 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. This course contains computational modules; some prior knowledge of computer programming is needed.
Prerequisite(s): EN.510.311 AND EN.500.113
Distribution Area: Engineering, Natural Sciences

EN.510.313. Mechanical Properties of Materials. 3 Credits.
An introduction to the properties and behavior of materials subjected to mechanical forces and deformation. Topics include the influence of composition and microstructure on the stiffness, strength, and toughness of materials. Particular emphasis is placed on fundamental mechanisms of deformation and fracture in the basic classes of materials (metals, ceramics, and polymers) as well as more complex materials (composites and biomaterials).
Prerequisite(s): EN.500.113 AND EN.510.312;EN.510.311 can be taken prior to enrolling in or at the same time as EN.510.313.
Distribution Area: Engineering, Natural Sciences

EN.510.314. Electronic Properties of Materials. 3 Credits.
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 conductivity and mobility, thermoelectricity, dielectric effects, piezoelectricity, photonic transmission and energetics, and magnetic phenomena. Mechanical force-based, quantum, and chemical explanations are presented and commonalities among them developed. Contemporary topics relevant to technology, sustainability, and medicine are explored.
Prerequisite(s): EN.510.311 AND EN.510.312
Distribution Area: Engineering, Natural Sciences

EN.510.315. Physical Chemistry of Materials II. 3 Credits.
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 multi-component systems, solidification, diffusional and diffusionless transformations, and interfacial phenomena. This course contains computational modules; some prior knowledge of computer programming is needed.
Prerequisite(s): EN.510.311 AND EN.510.312
Distribution Area: Engineering, Natural Sciences

EN.510.316. Foundations of Biomaterials. 3 Credits.
As one of the six courses in the Introduction to Materials Science series, this course offers an overview of principles and properties of polymeric and soft materials for biomedical applications. Topics include synthesis and structure-property relationship of polymeric materials, natural and biomimetic materials, biodegradable materials, hydrogels and stimuli-sensitive materials, surface property and characterizations of biomaterials. Recommended Course Background: Introductory Organic Chemistry I (AS.030.205 or the equivalent).
Prerequisite(s): ((AS.110.106 AND AS.110.107) OR (AS.110.108 AND AS.110.109) OR (AS.110.107 AND AS.110.108) OR (AS.110.106 AND AS.110.109)) AND (AS.030.103 OR(AS.030.101 AND AS.030.102)) AND ((AS.171.101 OR AS.171.103 OR AS.171.107) AND (AS.171.102 OR AS.171.104 OR AS.171.108)) AND AS.030.205
Distribution Area: Engineering, Natural Sciences

EN.510.335. MSE Design Team I. 3 Credits.
This course is the first half of a two-semester course sequence for freshmen, sophomores, and juniors majoring or double majoring in materials science and engineering (MSE). This course provides a broad exposure to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE freshmen, sophomores, and juniors, working with a team leader and seniors on the team, apply their general knowledge in MSE to develop the solution to open-ended problems. *The team will meet 150 minutes per week at a time to be designated by the instructor.Recommended Course Background: EN.510.101, EN.510.109, or equivalent courses.
Distribution Area: Engineering, Natural Sciences

EN.510.336. MSE Design Team I. 3 Credits.
This course is the second half of a two-semester course sequence for juniors majoring or double majoring in materials science and engineering (MSE). This course provides a broad exposure to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE juniors working with a team leader and seniors on the team, apply their general knowledge in MSE to develop the solution to open-ended problems. Materials Science & Engineering Freshman Only. Recommended Course Background: EN.510.106, EN.510.109, or equivalent courses. *The team will meet 150 minutes per week at a time to be designated by the instructor.
Prerequisite(s): EN.510.335
Distribution Area: Engineering, Natural Sciences

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
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.***

EN.510.402. Dynamics of Soft Materials. 3 Credits.
The structure and properties of soft materials will be studied with the focus on understanding ways to control and measure the dynamics. Soft materials to be studied include colloids, emulsions, dispersions, drops, polymers and gels. We will use experimental tools to study these materials including optical microscopy, rheometers, and atomic force microscopy. Recommended Course Background: EN.510.311 or permission of instructor.
Distribution Area: Engineering, Natural Sciences

510.407 (E, N) Biomaterials Principles and Applications. 3 credits.
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**

EN.510.414. Transmission electron microscopy: principle and practice. 3 Credits.
Introduction to basic principles of electron diffraction, phase contrast and Z-contrast and applications of these principles in microstructural characterization of materials by electron diffraction, high-resolution electron microscopy and scanning transmission electron microscopy. Also listed as EN.510.665.
Distribution Area: Engineering, Natural Sciences

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.**

EN.510.419. Physical Metallurgy. 3 Credits.
Fundamentals of metals and modern alloy systems, emphasizing the development and stability of microstructure and the physical basis linking microstructure to mechanical properties. Topics include thermodynamics of alloy systems, solidification, phase transformations, mechanisms of deformation and fracture, and alloy design. Examples will be drawn from a variety of systems including ferrous alloys (steels), lightweight alloys (aluminum and magnesium), alloys for high temperature applications (superalloys), and recent developments including metallic glasses and high-entropy alloys.
Prerequisite(s): EN.510.311 AND EN.510.313 AND EN.510.315
Distribution Area: Engineering, Natural Sciences

EN.510.420. Stealth Science & Engineering. 3 Credits.
The goal of stealth engineering is the creation of objects that are not easily detected using remote sensing techniques. To achieve this end, engineered systems of materials are arrayed to alter the signature of objects by reducing energy returned to remote observers. This course will provide an introduction to the general principles behind signature reduction by examining the mathematics and science behind basic electromagnetic and acoustic transport processes. Specific topics will include energy absorbing materials, anti-reflection coatings, wave guiding and scattering, metamaterials and adaptive screens. Co-listed with EN.510.640
Distribution Area: Engineering, Natural Sciences

510.422 (E, N) Micro- and Nano-Structured Materials and Devices. 3 Credits.
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.

EN.510.425. Advanced Materials for Battery. 3 Credits.
This class provides an overview of the basic principles of electrochemical energy storage and the essential roles of advanced materials in batteries. Materials selection and design for the anodes and cathodes of lithium and sodium batteries are introduced on the basis of crystallography and materials chemistry. State-of-the-art operando characterization techniques of battery materials are also discussed in the course. This course is also listed as EN.510.625.
Prerequisite(s): EN.510.311 AND EN.510.312
Distribution Area: Engineering, Natural Sciences

EN.510.426. Biomolecular Materials I - Soluble Proteins and Amphiphiles. 3 Credits.
This course will examine the fundamental structure, interactions, and function relationship for biological macromolecules. The course will emphasize experimental methods and experimental design, and the physics behind human disease. Topics will include micellization, protein folding and misfolding, and macromolecular interactions. Required Course Pre-Requisites: EN.580.221 & EN.510.312 - Co-listed with EN.510.621
Prerequisite(s): EN.580.221 AND EN.510.312
Distribution Area: Engineering, Natural Sciences

EN.510.428. Materials Science Laboratory I. 3 Credits.
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. Restricted to Materials Science & Engineering juniors only
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;EN.510.311;EN.510.313 may be taken prior to enrolling in, or at the same time as, EN.510.428
Corequisite(s): EN.510.315 AND EN.510.313 must be taken at the same time as EN.510.428.
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.429. Materials Science Laboratory II. 3 Credits.
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. Lab Assignment is by Professor. Recommended Course Background: EN.510.311 or Permission Required.
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;EN.510.311;EN.510.313 can be taken prior to enrolling, or at the same time as, EN.510.429.
Corequisite(s): EN.510.314 must be taken at the same time as EN.510.429.
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.430. Biomaterials Lab. 3 Credits.
This laboratory course focuses on the synthesis, characterization, and application of biomaterials in cellular and biomedical research. The class covers a broad range of scenarios where biomaterials play vital roles, including cell culture, gene delivery, tissue modeling, and cell sensing. Students will also learn the basic lab techniques in biomedical research, including cell and tissue cultures, heterologous gene expression, and cell imaging. Recommended Course Background: EN.510.407
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.433. Senior Design Research. 3 Credits.
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.Co-listed with EN.510.438 and EN.510.440
Prerequisite(s): (EN.510.311 AND EN.510.312 AND EN.510.313 AND EN.510.314 AND EN.510.315 EN.510.316) AND (EN.510.428 AND EN.510.429)
Distribution Area: Engineering
Writing Intensive

EN.510.434. Senior Design/Research II. 3 Credits.
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. Recommended Course Background: EN.510.311-EN.510.312, EN.510.428-EN.510.429, and EN.510.433Meets with EN.510.439, EN.510.441, EN.510.446, and EN.510.448
Prerequisite(s): EN.510.433
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.436. Biomaterials for Cell Engineering. 3 Credits.
This course focuses on the development of biomaterials both as new tools to study fundamental biology and as means to direct cell behavior and function for biomedical applications. Topics include the material properties of cells and tissue, biomaterials for recapitulating cell microenvironment, biomaterials for studying and directing cell mechanotransduction, biomaterials for gene editing, biomaterials for immunotherapy, and biomaterials for neuroengineering. This course will have in-depth discussions on recent findings and publications in these areas. This course is also listed as EN.510.636.
Prerequisite(s): (EN.510.316 OR EN.510.407 OR EN.510.610
Distribution Area: Engineering, Natural Sciences

EN.510.438. Biomaterials Senior Design I. 3 Credits.
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 research with a focus on biomaterials. 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 departmental research seminars.Co-listed with EN.510.440 and EN.510.433
Prerequisite(s): EN.510.311 AND EN.510.312 AND EN.510.313 AND EN.510.314 AND EN.510.315 AND EN.510.316 AND EN.510.428 AND EN.510.429
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.439. Biomaterials Senior Design II. 3 Credits.
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 research with a focus on biomatreials. 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 a written final report summarizing their design and research results. Recommended Course Background: EN.510.311-EN.510.312, EN.510.428-EN.510.429, and EN.510.433 or 510.438 or 510.440Meets with EN.510.434, EN.510.441, EN.510.446, and EN.510.448
Prerequisite(s): EN.510.311 AND EN.510.312 AND EN.510.313 AND EN.510.314 AND EN.510.315 AND EN.510.316 AND EN.510.428 AND EN.510.429
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.440. Nanomaterials Senior Design I. 3 Credits.
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 research with a focus on nanotechnology and nanomaterials. 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 departmental research seminars. Co-listed with EN.510.433 and EN.510.438
Prerequisite(s): (EN.510.311 AND EN.510.312 AND EN.510.313 AND EN.510.314 AND EN.510.315 EN.510.316) AND (EN.510.428 AND EN.510.429)
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.441. Nanomaterials Senior Design II. 3 Credits.
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 research with a focus on nanotechnology and nanomaterials. 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 a written final report summarizing their design and research results. Recommended Course Background: EN.510.311-EN.510.312, EN.510.428-EN.510.429, and EN.510.433 or 510.438 or 510.440Meets with EN.510.434, EN.510.439, EN.510.446, and EN.510.448
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.442. Nanomaterials Lab. 3 Credits.
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.
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Distribution Area: Engineering, Natural Sciences

EN.510.443. Chemistry and Physics of Polymers. 3 Credits.
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. Also listed as EN.510.643. Recommended Course Background: Organic Chemistry I and one semester of thermodynamics.
Distribution Area: Engineering, Natural Sciences

EN.510.445. MSE Design Team II. 3 Credits.
This course is the first half of a two-semester course sequence for senior students majoring or double majoring in MSE. This course provides a broad experience to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE seniors, working with a team leader and a group of freshmen, sophomores, and seniors, apply their knowledge in their track area to generate the solution to open-ended problems encountered in MSE. Recommended Course Background: EN.510.101, EN.510.311, EN.510.312, EN.510.428, EN 510.429.
Prerequisite(s): EN.510.311 AND EN.510.312 AND EN.510.313 AND EN.510.314 AND EN.510.315 AND EN.510.316 AND EN.510.428 AND EN.510.429
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.446. MSE Design Team II. 3 Credits.
This course is the second half of a two-semester course sequence for senior students majoring or double majoring in MSE. This course provides a broad experience to various aspects of planning and conducting independent research in a team setting (3 to 6 students on each team). In this course, MSE seniors, working with a team leader and a group of freshmen, sophomores, and seniors, apply their knowledge in their track area to generate the solution to open-ended problems encountered in MSE. Materials Science & Engineering Seniors Only.Recommended Course Background: EN 510.101, EN 510.311, EN 510.312, EN 510.428, EN 510.429.Meets with EN.510.434, EN.510.439, EN.510.441 and EN.510.448.
Prerequisite(s): EN.510.445;EN.510.311 AND EN.510.312 AND EN.510.313 AND EN.510.314 AND EN.510.315 AND EN.510.316 AND EN.510.428 AND EN.510.429
Distribution Area: Engineering, Natural Sciences

EN.510.447. MSE Design Team Leader. 4 Credits.
This course is the first half of a two-semester course sequence for students majoring or double majoring in MSE. This course provides a leadership experience to various aspects of planning and conducting independent research in a team setting. In this course, MSE seniors assemble and lead a student team consisting of 3 to 6 students, apply their knowledge in their track area, and develop leadership skills to generate the solution to open-ended problems encountered in MSE.Recommended Course Background: EN.510.101, EN.510.311, EN.510.312, EN.510.428, EN 510.429.
Distribution Area: Engineering, Natural Sciences
Writing Intensive

EN.510.448. MSE Design Team Leader. 4 Credits.
This course is the second half of a two-semester course sequence for students majoring or double majoring in MSE. This course provides a leadership experience to various aspects of planning and conducting independent research in a team setting. In this course, MSE seniors assemble and lead a student team consisting of 3 to 6 students, apply their knowledge in their track area, and develop leadership skills to generate the solution to open-ended problems encountered in MSE. Materials Science & Engineering Seniors Only.Recommended Course Background: EN 510.101, EN 510.311, EN 510.312,EN. 510.428, EN 510.429.Meets with EN.510.434, EN.510.439, EN.510.441, and EN.510.446
Prerequisite(s): EN.510.447
Distribution Area: Engineering, Natural Sciences

EN.510.451. Recycling for Sustainablility. 3 Credits.
"I'm so confused…which bin do I choose?" Recycling everyday materials and re-using objects made from them have been part of our country's materials-usage landscape for decades. However, as we engineer a sustainable future, recycling will become an ever-increasing component of our strategies for material selection and product design. This course provides an overview of recycling – from the basics of materials recovery, processing and re-use to its economic and environmental impacts. Students will learn about industrial practices associated with recycling and how these relate to our everyday consumer behaviors. Field experiences and laboratory demonstrations will expose students to the realities of recycling. The challenges associated with recycling will be examined to gain a greater understanding of issues related to the use of materials in a sustainable world.
Distribution Area: Engineering, Natural Sciences

EN.510.452. Materials in Extreme Environments. 3 Credits.
This survey course provides a broad perspective of the challenges materials face in evolving technologies related to energy production, aerospace, medicine, and even data storage. The course will introduce topics by technology and review the current materials in use, the challenges they face, and the future outlook in terms of opportunities, improvements, and research. Information will be provided from literature, media, and guest speakers from key industries and technology sectors.

EN.510.453. Materials Characterization. 3 Credits.
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 thermal analysis and surface analytical techniques, including Auger electron spectroscopy, secondary ion mass spectroscopy, X-ray photoelectron spectroscopy, and atomic force microscopy. Working with the JHU museums, we will use the techniques learned in class to characterize historic artifacts.
Distribution Area: Engineering, Natural Sciences

EN.510.454. Nanomaterials for Genetic Medicine. 3 Credits.
This course describes how nanomaterials have facilitated and will advance genetic medicine in clinical applications for disease treatment and prevention. Topics of this course include synthesis and structure-activity relationship of hard and soft nanoparticles, biomimetic nanomaterials, nanomaterials for nucleic acid delivery, nanomaterials for genome editor delivery, biological fate of nanomaterials, and nano-bio interface characterization. This course will have in-depth discussions on recent progress and publications in these areas.

EN.510.456. Computational modeling of soft/bio materials. 3 Credits.
This course provides an overview of computational modeling methods with practical applications for designing soft materials and biomaterials. Computational methods include Monte Carlo, molecular dynamics, Bayesian analysis, machine learning, and the basics of finite-element modeling. The course is part project-based and teaches both the fundamentals of computational methods and how to apply them to current cutting-edge research in soft and biomaterials.
Prerequisite(s): Students who have taken or are enrolled in EN.510.656 are not eligible to take EN.510.456.;EN.500.113 AND EN.510.312

EN.510.457. 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. Co-listed with EN.510.657
Distribution Area: Engineering, Natural Sciences

EN.510.466. Introduction to Computational Materials Modeling. 3 Credits.
Moore's law has given rise to the silicon age, where computational modeling can provide high-fidelity predictions to address challenges spanning climate change and renewable energy to economic stability and global pandemics. The skills to solve scientific problems computationally have become invaluable in virtually all industries. This introductory course is project-based and puts into practice the fundamentals of software development, numerical analysis, and scientific programming. Topics covered include methods for solving differential equations, Monte Carlo and atomistic simulations, machine learning, and data visualization. The course is taught in Python, and support for non-UNIX architectures is limited.
Prerequisite(s): EN.500.113 AND EN.510.311 AND EN.510.312

EN.510.467. Metal Additive Manufacturing. 3 Credits.
Additive Manufacturing (AM), also known colloquially as 3D Printing, is a disruptive technology that has received significant attention in recent years in both the popular press and the manufacturing industry. While the current and potential future applications for this technology, especially for mission-critical metal parts, are impressive and imaginative, the full potential for metal AM has not been realized due to current limitations and a lack of full understanding of metal AM processes. In this class we will cover (1) the current state-of-the-art of AM; (2) the production steps necessary to manufacture AM parts; and (3) the closely linked topics of AM materials and AM processes. While non-metal AM materials such as polymers, composites, and ceramics will be included, the primary focus will be on metal materials fabricated with laser powder bed fusion processes. Specific topics covered will include conventional vs. AM materials, meltpool phenomena including solidification, kinetics and solid-state kinetics, post-process thermal treatments, the process-properties relationship, in-situ process sensing, indirect process measurement methods and process modeling. Recent implementations of metal additive manufacturing, such as those in the aerospace and health care industries, will be presented extensively throughout the class as study cases. Popular press articles and technical papers on AM will be reviewed and discussed. Students taking this class will be expected to participate actively and bring to the class real or potential applications of AM in their workplaces.Co-listed with EN.510.667
Prerequisite(s): EN.510.311 AND EN.510.315
Distribution Area: Engineering, Natural Sciences

EN.510.501. Undergraduate Research in Material Science. 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.
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class.;You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

EN.510.502. Research in Materials Science. 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.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

EN.510.504. Independent Study. 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(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

EN.510.511. Group Undergraduate Research/Material Science. 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. This section has a weekly research group meeting that students are expected to attend.
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class.;You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

EN.510.597. Research - Summer. 3 Credits.
Undergraduates who want to do Independent Academic Work with a department faculty member in the summer must use the Independent Academic Work form found in Student Self-Service: Registration Online Forms.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

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/.

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The offices for the staff of Materials Science & Engineering are located in Maryland Hall on the second floor. The staff works a hybrid schedule where some days are remote. The Program Administrator works in the office Tuesday-Thursday and remotely Monday/Wednesdays.

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