Materials Science and Technology (BA/BS)

Jayson Paulose, Program Director

Materials Science and Technology major will focus on the properties of materials needed for modern technology, and how they relate to the underlying physical and chemical structure.

Materials are the functional components of modern technology - electrodes for rechargeable batteries, semiconductors, conductors, and insulators in electronics for classical and quantum computers, polymers/plastics, sensors, and much more. Materials scientists invent new materials and study the connections between underlying atomic/molecular structure of a materials, its properties, its processing methods, and its performance in applications.

Admission

Students will be required to apply for admission into the MSTC major after completing the foundational course sequences in physics (PHYS 201/2/3 or 251/2/3 + lab), chemistry (CH 221/2/3 or 224/5/6H + lab), materials science (MSTC 231/232), and the CH329 Research Immersion course. Students will be asked to provide their academic transcript and potential research/industry area of interest as part of the application.

The requirement for admission is achieving a GPA of 3.0 or better in the foundational courses. Students not meeting this requirement, but with a strong academic record that demonstrates steady progress towards acquiring the quantitative and critical thinking skills necessary for success in the program, can petition for admission to the program through additional review. In addition to application materials listed above, applicants will be asked to provide a CV; short essay responses to prompts that aim to evaluate their clarity of purpose and dedication with regard to academic/career goals, ability to overcome obstacles, and ability to tackle open-ended research questions; and references from 1-2 instructors in the foundational courses. Applications will be evaluated by a three-member committee with members drawn from chemistry and physics faculty.

See program's website (https://naturalsciences.uoregon.edu/materials-science-technology/apply/declare-major-minor) for more details.

Program Learning Outcomes

Upon successful completion of this program, students will be able to:

- Learn and critically apply basic concepts in chemical bonding to understand the three-dimensional solid-state structure of different classes of materials.
- Describe how basic classes of materials are made and processed for applications in renewable energy, health, sustainable building, and computing.
- Understand how diffusion processes are driven by gradients in chemical potential and how those relate to materials synthesis, failure, and function.
- Understand the basic thermodynamics and applications of phase diagrams while formulating fundamental thermodynamic definitions of work, heat, reversibility ,and apply these relationships to technological applications such as batteries, photovoltaic power, fuel cells, thermoelectric power, and sensors\
- Understand how materials thermodynamics defines electrochemical equilibration in energy storage systems and governs optical and magnetic properties of materials.
- Understand the structure and defect concepts governing the mechanical properties of materials, like hardness, strength, stress-strain behavior, plastic deformation, in structural and engineering applications.
- Understand the basic structure and defect concepts governing the electrical properties of materials, like conductivity, in computing applications.
- Understand the basic structure and defect concepts governing the magnetic properties of materials, like diamagnetism, paramagnetism, and ferromagnetism and applications for example in electric motors, magnetic information storage, and quantum information science.
- Understand how microscopic kinetic pictures of materials reactions gives rise to key processes in technological systems, for example electrode reactions, nucleation and growth, and interface and crystal grain behavior with time.
- Connect fundamentals of materials science to technological applications.
- Gain high-level competency in modern programming languages for data manipulation and analysis, and to model materials behavior.
- Gain laboratory competence in materials science and ability to work individually and with teams on solving unstructured problems.

Materials Science and Technology Major Requirements

Courses used to fulfill the major requirements must be taken for a letter grade and passed with a grade of C- or better.

Code	Title	Credits
Foundation courses		
CH 221Z	General Chemistry I	4
or CH 224H	Advanced General Chemistry I	
CH 222Z	General Chemistry II	4
or CH 225H	Advanced General Chemistry II	
CH 223Z	General Chemistry III	4
or CH 226H	Advanced General Chemistry III	
CH 329	Research Immersion Laboratory	3
MSTC 231	Fundamentals of Materials in Technology I	4
MSTC 232	Fundamentals of Materials in Technology II	4
PHYS 251–253	Foundations of Physics I [1]	12
Select one of the lab options:		2-4
Option A:		
PHYS 290	Foundations of Physics Laboratory (Taken two times)	
Option B:		
PHYS 204	Introductory Physics Laboratory	
PHYS 205	Introductory Physics Laboratory	
Option C:		
CH 227Z	General Chemistry I Laboratory	
CH 228Z	General Chemistry II Laboratory	
Mathematics and Computation		
MATH 251Z–253Z	Calculus: Differential, Integral, and Sequences & Series	12
MATH 256	Introduction to Differential Equations	4

MATH 281	Several-Variable Calculus I	4
Advanced Math/Computation Electives - select two		8
CH 447	Computational Chemistry	
CS 210	Computer Science I	
MATH 282	Several-Variable Calculus II	
MATH 341	Elementary Linear Algebra	
MATH/PHYS 421M	Partial Differential Equations: Fourier Analysis I	
MATH 422	Partial Differential Equations: Fourier Analysis II	
PHYS 389	Mathematical Methods	
PHYS 445	Computational Physics	
Fundamentals of Materials Science		
Quantum and Statistical Mechanics sequence		12
CH 411–413	Physical Chemistry	
or PHYS 351-353	Foundations of Physics II	
MSTC 431	Thermal Physics of Advanced Materials	4
MSTC 432	Kinetics and Transport in Advanced Materials	4
Advanced Lab courses - select three of the following: [2]		12
CH 417	Physical Chemistry Laboratory	
CH 418	Physical Chemistry Laboratory	
CH 419	Physical Chemistry Laboratory	
CH 429	Instrumental Analysis	
DSCI 101	Foundations of Data Science I	
PHYS 391	Physics Experimentation Data Analysis Laboratory	
PHYS 431	Analog Electronics	
PHYS 432	Digital Electronics	
PHYS 481	Design of Experiments	
Materials Science and Technology focus area		
Choose one option below, within which eight credits must be completed.		8
Option A: Solid-state materials and devices		
MSTC/PHYS 441M	Electronic, Optical and Magnetic Properties of Materials I	
MSTC/PHYS 442M	Electronic, Optical and Magnetic Properties of Materials II	
Option B: Soft/biological materials - choose two courses out of:		
BIOE 410	Experimental Course: [Topic] (Biomaterials)	
CH 410	Experimental Course: [Topic] (Polymer Materials)	
PHYS 444	Introduction to Biological Physics	
Upper-Division Electives		
Three 400- or 500-level courses in materials science, chemistry, or physics on top of the courses outlined above. [3]		12
Total Credits		**117-119**

[1] Students can petition to count PHYS 201-203 instead.

[2] Other upper-level lab courses from natural or applied sciences may be requested by petition. Up to four Advanced Lab credits may be fulfilled by undergraduate research credits (PHYS 401, PHYS 491, PHYS 492, PHYS 493, CH 401) instead of courses listed.

[3] Courses at 500 level are appropriate for students in Accelerated Master's programs.

Four-Year Degree Plan

The degree plan shown is only a sample of how students may complete their degrees in four years. There are alternative ways. Students should consult their advisor to determine the best path for them.

Bachelor of Science in Materials Science and Technology (Solid-state materials and devices)

Course	Title	Credits Milestones
First Year		
Fall		
CH 150Z	Preparatory Chemistry	4
MATH 111Z	Precalculus I: Functions	4
WR 121Z	Composition I	4
Core Ed		4
	Credits	**16**
Winter		
CH 221Z	General Chemistry I	4
MATH 112Z	Precalculus II: Trigonometry	4
WR 122Z	Composition II	4
Core Ed		4
	Credits	**16**
Spring		
CH 222Z	General Chemistry II	4
MATH 251Z	Differential Calculus	4
DSCI 101	Foundations of Data Science I	4
Core Ed		4
	Credits	**16**
Second Year		
Fall		
CH 223Z	General Chemistry III	4
MATH 252Z	Integral Calculus	4
PHYS 251	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
Core Ed		4
	Credits	**17**
Winter		
MATH 253Z	Calculus: Sequences and Series	4
MSTC 231	Fundamentals of Materials in Technology I	4
PHYS 252	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
Core Ed		4
	Credits	**17**
Spring		
CH 329	Research Immersion Laboratory	3
MATH 256	Introduction to Differential Equations	4

MSTC 232	Fundamentals of Materials in Technology II	4
PHYS 253	Foundations of Physics I	4
PHYS 290	Foundations of Physics Laboratory	1
Core Ed		4
	Credits	**20**
Third Year		
Fall		
MATH 281	Several-Variable Calculus I	4
PHYS 351	Foundations of Physics II	4
PHYS 391	Physics Experimentation Data Analysis Laboratory	4
Core Ed		4
	Credits	**16**
Winter		
MSTC 441M	Electronic, Optical and Magnetic Properties of Materials I	4
PHYS 352	Thermal Physics and Statistical Mechanics I	4
PHYS 389	Mathematical Methods	4
Core Ed		4
	Credits	**16**
Spring		
MSTC 442M	Electronic, Optical and Magnetic Properties of Materials II	4
PHYS 353	Thermal Physics and Statistical Mechanics II	4
PHYS 432	Digital Electronics	4
Core Ed		4
	Credits	**16**
Fourth Year		
Fall		
PHYS 445	Computational Physics	4
UD Elective for MSTC major		4
Electives		4
	Credits	**12**
Winter		
MSTC 431	Thermal Physics of Advanced Materials	4
PHYS 431	Analog Electronics	4
UD Elective for MSTC major		4
	Credits	**12**
Spring		
MSTC 432	Kinetics and Transport in Advanced Materials	4
UD Elective for MSTC major		4
	Credits	**8**
	Total Credits	**182**

Bachelor of Science in Materials Science and Technology (Soft/biological materials)

Course	Title	Credits Milestones
First Year		
Fall		
CH 150Z	Preparatory Chemistry	4
MATH 111Z	Precalculus I: Functions	4
WR 121Z	Composition I	4
Core Ed		4
	Credits	**16**
Winter		
CH 221Z	General Chemistry I	4
CH 227Z	General Chemistry I Laboratory	1
MATH 112Z	Precalculus II: Trigonometry	4
WR 122Z	Composition II	4
Core Ed		4
	Credits	**17**
Spring		
CH 222Z	General Chemistry II	4
CH 228Z	General Chemistry II Laboratory	1
MATH 251Z	Differential Calculus	4
DSCI 101	Foundations of Data Science I	4
Core Ed		4
	Credits	**17**
Second Year		
Fall		
CH 223Z	General Chemistry III	4
MATH 252Z	Integral Calculus	4
PHYS 251	Foundations of Physics I	4
Core Ed		4
	Credits	**16**
Winter		
MATH 253Z	Calculus: Sequences and Series	4
MSTC 231	Fundamentals of Materials in Technology I	4
PHYS 252	Foundations of Physics I	4
Core Ed		4
	Credits	**16**
Spring		
CH 329	Research Immersion Laboratory	3
MATH 256	Introduction to Differential Equations	4
MSTC 232	Fundamentals of Materials in Technology II	4
PHYS 253	Foundations of Physics I	4
Core Ed		4
	Credits	**19**
Third Year		
Fall		
CH 411	Physical Chemistry	4
CH 417	Physical Chemistry Laboratory	4
MATH 281	Several-Variable Calculus I	4

Core Ed		4
	Credits	**16**
Winter		
CH 412	Physical Chemistry	4
CH 418	Physical Chemistry Laboratory	4
MATH 282	Several-Variable Calculus II	4
MSTC 431	Thermal Physics of Advanced Materials	4
	Credits	**16**
Spring		
MSTC 432	Kinetics and Transport in Advanced Materials	4
CH 413	Physical Chemistry	4
CH 419	Physical Chemistry Laboratory	4
	Credits	**12**
Fourth Year		
Fall		
CH 410	Experimental Course: [Topic] (Polymer Materials)	4
UD Elective for MSTC major		4
Electives		4
	Credits	**12**
Winter		
BIOE 410	Experimental Course: [Topic] (Biomaterials)	4
CH 447	Computational Chemistry	4
UD Elective for MSTC major		4
	Credits	**12**
Spring		
UD Elective for MSTC major		4
Electives		8
	Credits	**12**
	Total Credits	**181**