Materials Engineering

Interim Chair: Gregg M. Janowski, PhD

Degree Offered	Bachelor of Science in Materials Engineering
Accreditation	The Bachelor of Science in Materials Engineering degree program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Materials, Metallurgical, Ceramics and Similarly Named Engineering Programs.
Website	https://www.uab.edu/engineering/mse/undergraduate
Program Director	Haibin Ning, PhD
Email	ning@uab.edu
Phone	205-934-8450

Materials engineering utilizes the interrelationships among structure, properties, and processing to achieve performance in the application of metals, ceramics, polymers, and composites to meet the needs of society. Students learn how to select the optimum material, design new materials and processes, and predict behavior under various environmental and service conditions. Materials Engineers are employed in every major industry, including aerospace, chemical, automotive, metals casting, biomedical, and microelectronics.

Students take a core of fundamental engineering coursework and a sequence of materials engineering courses in addition to courses in mathematics; calculus-based physics; chemistry; humanities and fine arts; and history, social, and behavioral sciences. The required materials engineering courses address ceramics, polymers, composite materials, and metals. Materials engineering elective courses are also offered to introduce students to leading-edge materials engineering topics. Students can specialize in Biomaterials by proper selection of their electives (see Concentration in Biomaterials). The curriculum prepares graduates to enter industry, pursue graduate studies, or enter a professional school, such as medicine or dentistry. The department has active research programs in metal casting, biomaterials, ceramic materials, and composite materials. The department also offers courses of study leading to the Master of Science in Materials Engineering and Doctor of Philosophy degrees in both Materials Engineering and Materials Science. These programs are described in the UAB Graduate School Catalog.

Please refer to the School of Engineering overview for policies regarding admission; change of major; transfer credit; transient status; dual degree programs; reasonable progress; academic warning, probation, and suspension; reinstatement appeals; and graduation requirements.

Vision

To be a nationally and internationally recognized research-oriented program - a first choice for undergraduate and graduate education

Mission

To excel in research for the benefit of society while educating students at all levels to be immediately productive.

Program Educational Objectives

Our Materials Engineering undergraduate program will produce functioning professionals who:

- Advance in materials engineering or related professional positions
- Continue to develop intellectually and professionally

Student Outcomes

Upon completion of the BSMtE degree program, our graduates will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Bachelor of Science in Materials Engineering

Requirements		Hours
Core Curriculum as Specified for Engineering Majors		**36**
Area I: Written Composition (6 hrs)		
Area II: Humanities and Fine Arts (9 hrs)		
Area III: Natural Sciences and Mathematics (12 hrs)		
MA 125 & 125L	Calculus I and Calculus I Lab	
PH 221 & 221L & 221R	General Physics I and General Physics Laboratory I and General Physics I Recitation	
PH 222 & 222L & 222R	General Physics II and General Physics Laboratory II and General Physics II - Recitation	
Area IV: History, Social, and Behavioral Sciences (9 hrs)		
Other Required Courses		**80**
CE 210	Statics	
CE 220	Mechanics of Solids	
CH 115 & 115R & CH 116	General Chemistry I and General Chemistry I Recitation and General Chemistry I Laboratory	

CH 117 & 117R & CH 118	General Chemistry II and General Chemistry II Recitation and General Chemistry II Laboratory	
EE 312	Electrical Systems	
EGR 110 & EGR 111 or EGR 200	Introduction to Engineering I and Introduction to Engineering II Introduction to Engineering	
EGR 150	Computer Methods in Engineering	
EGR 265	Math Tools for Engineering Problem Solving [1]	
MA 126	Calculus II	
ME 251	Introduction to Thermal Sciences	
MSE 280	Engineering Materials	
MSE 281 & 281L	Physical Materials I and Physical Materials I Laboratory	
MSE 380	Thermodynamics of Materials	
MSE 381	Physical Materials II	
MSE 382	Mechanical Behavior of Materials	
MSE 401	Materials Processing	
MSE 413	Composite Materials	
MSE 425	Statistics and Quality	
MSE 430 & 430L	Polymeric Materials and Polymeric Materials Laboratory	
MSE 464 & 464L	Metals and Alloys and Metals and Alloys Laboratory	
MSE 465 & 465L	Characterization of Materials and Characterization of Materials Laboratory	
MSE 470 & 470L	Ceramic Materials and Ceramic Materials Laboratory	
MSE 498	Capstone Design Project I	
MSE 499	Capstone Design Project II	
Materials Engineering Elective [1]		**3**
MSE 405	Frontiers of Automotive Materials	
MSE 408	Nanobiomaterials	
MSE 409 & 409L	Principles of Metal Casting and Principles of Metal Casting Laboratory	
MSE 433	Nondestructive Evaluation of Materials	
MSE 462	Composites Manufacturing	
MSE 474	Metals and Alloys II	
Mathematics/Science Elective		**3**
Any Biology (BY) courses numbered BY 108 or above		
Any Chemistry (CH) courses numbered CH 200 or above		
MA 260	Introduction to Linear Algebra	
MA 360	Scientific Programming	
MA 361	Mathematical Modeling	
Any Mathematics (MA) courses numbered MA 434 or above		
Any Physics (PH) courses numbered PH 223 or above		
Engineering/Mathematics/Science Electives [2]		**6**
CS 103	Introduction to Computer Science in Python	
CS 203	Object-Oriented Programming in Java	
Any course listed in the Mathematics/Science Electives section		
Any engineering course not required in the major except CE 344, EE 300, EE 305, EE 314, EGR 301, ME 241, ME 302, MSE 350, or any capstone/senior project course, or any honors research hours from another program.		
Total Hours		**128**

[1] Students may also take MA 227 and MA 252 instead of EGR 265 and approved Math/Science elective.

[2] Completion of Departmental Honors Program satisfies three credits of either a Materials Engineering Elective or an Engineering/Mathematics/Science Elective.

Residency Requirement

In addition to UAB's residency requirement, to earn a bachelor of science in materials engineering from UAB, the program requires that students complete the following courses at UAB:

Requirements		Hours
Three courses from the following:		9
MSE 401	Materials Processing	
MSE 413	Composite Materials	
MSE 430	Polymeric Materials	
MSE 464	Metals and Alloys	
MSE 465	Characterization of Materials	
MSE 470	Ceramic Materials	
MSE 498	Capstone Design Project I	3
MSE 499	Capstone Design Project II	3
Total Hours		**15**

Concentration in Biomaterials

Students seeking the degree of BSMtE may add a concentration in Biomaterials by appropriate selection of their MSE Elective and Science/Mathematics/Engineering Electives (9 credit hours total).

Requirements		Hours
BME 311	Biomaterials for Non-Majors	3
Elective Courses		
Select two from the following:		6
BME 420	Implant-Tissue Interactions	
BME 435	Tissue Engineering	
MSE 408	Nanobiomaterials	
Total Hours		**9**

Concentration in Metallurgy

Students seeking the degree of BSMtE may add a concentration in Metallurgy by appropriate selection of their MSE Elective and Science/Mathematics/Engineering Electives (9 credit hours total).

Requirements		Hours
Elective Courses		
Select three from the following:		9
MSE 405	Frontiers of Automotive Materials	
MSE 409	Principles of Metal Casting	
MSE 433	Nondestructive Evaluation of Materials	
MSE 474	Metals and Alloys II	
Total Hours		**9**

Concentration in Polymer Matrix Composites

Students seeking the degree of BSMtE may add a concentration of Polymer Matrix Composites by appropriate selection of their MSE Elective and Science/Mathematics/Engineering Electives (10 credit hours total). CH 235/CH 236 may be used as the Science/Mathematics Elective instead of one of the Science/Mathematics/Engineering Electives.

Requirements		Hours
CH 235	Organic Chemistry I	3
CH 236	Organic Chemistry I Laboratory	1
Elective Courses		
Select two from the following:		6
MSE 405	Frontiers of Automotive Materials	
MSE 408	Nanobiomaterials	
MSE 433	Nondestructive Evaluation of Materials	
MSE 462	Composites Manufacturing	
Total Hours		**10**

Curriculum for the Bachelor of Science in Materials Engineering (BSMtE)

Freshman

First Term	Hours	Second Term	Hours
CH 115 & 115R & CH 116	4	EGR 111[1]	1
EGR 110[1]	1	EH 102	3
MA 125 & 125L	4	CH 117 & 117R & CH 118	4
ME 102	2	PH 221 & 221L & 221R	4
EH 101	3	MA 126	4
	14		**16**

Sophomore

First Term	Hours	Second Term	Hours
CE 210	3	CE 220	3
EGR 265[2]	4	EE 312	3
MSE 280	3	ME 251	2
PH 222 & 222L & 222R	4	MSE 281 & 281L	4
Core Curriculum Area II or IV[3]	3	EGR 150	3
		Core Curriculum Area II or IV[3]	3
	17		**18**

Junior

First Term	Hours	Second Term	Hours
MSE 380	3	MSE 382	3
MSE 381	3	MSE 464 & 464L	4
MSE 401	3	MSE 470 & 470L	4
MSE 425	3	Science/Mathematics Elective[4]	3
MSE 465 & 465L	4	Core Curriculum Area II or IV[3]	3
	16		**17**

Senior

First Term	Hours	Second Term	Hours
MSE 413	3	MSE 430 & 430L	3
MSE 498	3	MSE 499	3
Engineering/Math/Science Elective[4]	3	Materials Engineering Elective[4]	3
Core Curriculum Area II or IV[3]	6	Engineering/Math/Science Elective[4]	3
		Core Curriculum Area II or IV[3]	3
	15		**15**

Total credit hours: 128

1. Transfer students may substitute EGR 200 for EGR 110 and EGR 111.
2. Students may also take MA 227 and MA 252 for EGR 265 and either the MA/SCI or one EGR/MA/SCI elective.
3. Please refer to the Core Curriculum as specified for Engineering majors.
4. Completion of Departmental Honors Program satisfies three credits of either a Materials Engineering Elective or an Engineering/Mathematics/Science Elective.

Courses

MSE 011. Undergraduate Internship in MSE. 0 Hours.
Engineering internship experience in preparation for the student's intended career. Students in a university recognized cooperative education experience should register for COP 011 or COP 012.

MSE 280. Engineering Materials. 3 Hours.
Fundamentals of materials engineering, including terminology, mechanical testing and behavior, heat treating, and processing of metals, ceramics, polymers, and composites. Degradation of materials and criteria for materials selection. Course requires completion of 4 credits of Area III Science.

MSE 281. Physical Materials I. 4 Hours.
Structure of metals, ceramics and polymers; crystal bonding; phase diagrams, diffusion, dislocations and grain boundaries. Applications to the iron-carbon system, including heat treatment. MSE 281L must be taken concurrently.
Prerequisites: (MA 125 [Min Grade: C] or MA 225 [Min Grade: C]) and MSE 280 [Min Grade: C]

MSE 281L. Physical Materials I Laboratory. 0 Hours.
Laboratory component of MSE 281 and must be taken concurrently with MSE 281.

MSE 350. Introduction to Materials. 3 Hours.
Concepts and applications, crystal structure of materials, formation of microstructures, and selected structure-property relationships. Not available for credit toward engineering major. For non-engineering majors only.

MSE 380. Thermodynamics of Materials. 3 Hours.
First, second, and third laws of thermodynamics. Gibbs free energy, heat capacity, enthalpy, entropy, and relationships between thermodynamic functions. Free-energy versus composition relationships; behavior of ideal and non-ideal solutions; concept of thermodynamic activity of components in solution. Applications to materials systems.
Prerequisites: CH 117 [Min Grade: D] and CH 118 [Min Grade: D] and (MA 126 [Min Grade: C] or MA 226 [Min Grade: C]) and MSE 280 [Min Grade: D]

MSE 381. Physical Materials II. 3 Hours.
Microstructural changes in response to temperature and time; vacancies, annealing, diffusion, nucleation and growth kinetics. Equilibrium and non-equilibrium microstructures. Applications to precipitation hardening and solidification of metals.
Prerequisites: MSE 281 [Min Grade: D]

MSE 382. Mechanical Behavior of Materials. 3 Hours.
Microscopic deformation mechanisms in materials leading to macroscopic properties of fatigue; creep; ductile, transitional, and brittle fracture; friction; and wear. CE 220 (Mechanics of Solids) is recommended as a prerequisite for this course.
Prerequisites: MSE 281 [Min Grade: D]

MSE 401. Materials Processing. 3 Hours.
Processing of metals, ceramics, polymers, and composites. Casting, forging, rolling, welding, powder processing, 3D printing, compression molding, and other advanced methods. Ethics and Civic Responsibility are significant components of this course.
Prerequisites: MSE 280 [Min Grade: D] and (BME 333 [Min Grade: D] or CE 220 [Min Grade: D])

MSE 405. Frontiers of Automotive Materials. 3 Hours.
Advanced lightweight automotive materials, manufacturing and modeling techniques. Technology advancements in cost-effective carbon, glass and related reinforcements; "green" and sustainable materials, crashworthiness and injury protection of occupants and pedestrians, metal castings, heavy truck, mass transit, fuel cell and hybrid vehicles.
Prerequisites: MSE 281 [Min Grade: D]

MSE 408. Nanobiomaterials. 3 Hours.
Basic tools of nanotechnology, building blocks of nanostructured materials. Behavior of materials with nanoscale structures and their technological applications, including automotive, medical, and electronic applications. Introduction to biomaterials and nanobiomaterials, concepts in tissue engineering with special focus on nanoscaffolds for tissue engineering, nanoparticles in drug delivery and safety and toxicity of nanomaterials.
Prerequisites: MSE 280 [Min Grade: D]

MSE 409. Principles of Metal Casting. 3 Hours.
Engineering theory and practice on the production of cast ferrous (gray iron, ductile iron, steel) and non-ferrous metals (brass, bronze, aluminum). Producer requirements/responsibilities such as part and mold design, material specifications, and testing requirements are discussed. Laboratory on common testing and production methods and analysis and handling techniques required to produce high quality castings.
Prerequisites: MSE 280 [Min Grade: D]

MSE 409L. Principles of Metal Casting Laboratory. 0 Hours.
Laboratory component of MSE 409 and must be taken concurrently with MSE 409.

MSE 413. Composite Materials. 3 Hours.
Processing, structure, and properties of metal-, ceramic-, and polymer-matrix composite materials. Roles of interfacial bond strength, reinforcement type and orientation, and matrix selection in physical and mechanical properties of composite materials. MSE 382 (Mechanical Behavior of Materials) is recommended as a prerequisite for this course. Writing is a significant component of this course.
Prerequisites: MSE 281 [Min Grade: D]

MSE 425. Statistics and Quality. 3 Hours.
This course is arranged to reflect the sequential steps an engineer or scientist take to assess process capability and implement process improvement studies. There is a focus on connecting the theoretical equations to practical examples as well as interpreting and communicating of statistical results.
Prerequisites: MSE 281 [Min Grade: D]

MSE 430. Polymeric Materials. 3 Hours.
Processing methods, structure/engineering/property relationships, and applications of polymeric materials.
Prerequisites: MSE 281 [Min Grade: D] and (CH 117 [Min Grade: D] or CH 127 [Min Grade: D]) and (CH 118 [Min Grade: D] or CH 128 [Min Grade: D])

MSE 430L. Polymeric Materials Laboratory. 0 Hours.
Laboratory component of MSE 430 and must be taken concurrently with MSE 430.

MSE 433. Nondestructive Evaluation of Materials. 3 Hours.
This course reviews the principles, history, applications, and strengths/weaknesses of the five primary NDE techniques (RT, UT, EC, MP, and LP) with an emphasis on the fundamentals and techniques of each testing method. Importance of NDE on part performance and engineering design is also discussed.
Prerequisites: MSE 281 [Min Grade: D]

MSE 445. The Evolution of Engineering Materials. 3 Hours.
Past, present and future of engineering materials; how new materials and processing methods have impacted human society, from the Stone Age until today. Taught as a 3-week study abroad course in Germany, with visits to universities, industrial facilities, research labs, museums and selected cultural sites.
Prerequisites: MSE 280 [Min Grade: D]

MSE 462. Composites Manufacturing. 3 Hours.
Principles of manufacturing and processing of polymeric matrix composites. Production techniques including filament winding, pultrusion, and liquid infusion techniques combined with design, environmental and manufacturing issues of polymer matrix composites.
Prerequisites: MSE 281 [Min Grade: D]

MSE 464. Metals and Alloys. 4 Hours.
Microstructures, properties, heat treatment, and processing of ferrous and nonferrous materials.
Prerequisites: MSE 281 [Min Grade: D]

MSE 464L. Metals and Alloys Laboratory. 0 Hours.
Laboratory component of MSE 464 and must be taken concurrently with MSE 464.

MSE 465. Characterization of Materials. 4 Hours.
Theory and practice of materials characterization, with emphasis on optical metallography, quantitative metallography, scanning electron microscopy, crystallography, and x-ray diffraction. Specific applications in metals and ceramics considered. MSE 465L must be taken concurrently.
Prerequisites: MSE 281 [Min Grade: D]

MSE 465L. Characterization of Materials Laboratory. 0 Hours.
Laboratory component of MSE 465 and must be taken with MSE 465.

MSE 470. Ceramic Materials. 4 Hours.
Structure, processing, properties, and uses of ceramic compounds and glasses. Mechanical, thermal, and electrical behavior of ceramic materials in terms of microstructure and processing variables.
Prerequisites: MSE 281 [Min Grade: D] and CH 117 [Min Grade: D] and CH 118 [Min Grade: D]

MSE 470L. Ceramic Materials Laboratory. 0 Hours.
Laboratory component of MSE 470 and must be taken concurrently with MSE 470.

MSE 474. Metals and Alloys II. 3 Hours.
Production and physical metallurgy of ferrous and non-ferrous alloys including: steel alloys, inoculation and production of ductile, gray, compacted and malleable iron; advanced heat treatments of steel and iron; conventional and ultra-high strength aluminum alloys; wrought and cast copper alloys; wrought and cast magnesium alloys.
Prerequisites: MSE 281 [Min Grade: D] and MSE 464 [Min Grade: D] (Can be taken Concurrently)

MSE 489. Undergraduate Research in MSE. 0 Hours.
Undergraduate research experiences in materials science and/or engineering.
Prerequisites: (EGR 110 [Min Grade: C] and EGR 111 [Min Grade: C]) or EGR 200 [Min Grade: C] or HC 111 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C]) and PH 221 [Min Grade: C](Can be taken Concurrently)

MSE 490. Special Topics in Materials Engineering. 1-6 Hour.
Special Topics in Materials Engineering.

MSE 491. Individual Study in Materials Engineering. 1-6 Hour.
Individual Study in Materials Engineering.

MSE 496. MSE Honors Seminar. 1 Hour.
Research presentations by faculty, students, and invited guests on topics related to Materials Science and Engineering.

MSE 497. MSE Honors Research. 2-6 Hours.
Honor students develop materials engineering research skills by working closely with faculty and graduate students.
Prerequisites: EGR 301 [Min Grade: C](Can be taken Concurrently)

MSE 498. Capstone Design Project I. 3 Hours.
Capstone design project: interdisciplinary design teams, ethics, materials selection, design process, development of proposal, project planning and scheduling, project execution and resource scheduling, and communication of design. Writing is a significant component of this course.
Prerequisites: MSE 401 [Min Grade: D](Can be taken Concurrently) and (MSE 413 [Min Grade: D] or MSE 430 [Min Grade: D] or MSE 465 [Min Grade: D] or MSE 470 [Min Grade: D])

MSE 499. Capstone Design Project II. 3 Hours.
Continuation of MSE 498 which must be taken in the previous term. Interim and final design reviews with written and oral reports. Writing is a significant component of this course.
Prerequisites: MSE 498 [Min Grade: D]