

Materials Science and Engineering (BS): Nanomaterials Concentration

The Materials Science and Engineering (BS): Nanomaterials Concentration provides a comprehensive understanding of materials science and engineering, emphasizing the unique properties of materials at the nanoscale. This concentration delves into the fundamental principles governing the interactions and characteristics of materials at the atomic levels. Students explore advanced topics such as the design and manipulation of ultra-thin films, nanowires, nanoparticles, and other nanostructures and gain a deep understanding of how nanoscale phenomena—such as quantum confinement, surface area effects, and interfacial properties—differ from the behaviors observed in bulk materials. They also study how engineering materials at the nanoscale can impact their structural and functional properties, enabling groundbreaking applications in fields such as electronics, energy storage, biotechnology, and advanced manufacturing.

Admission

Students complete the standard set of engineering first-year courses, which include courses in the humanities, chemistry, mathematics, physics, and computing. Students may apply to join the Department of Materials Science and Engineering as degree-seeking students via the CODA process (<https://www.engr.ncsu.edu/academics/undergrad/coda/>). Students can declare a nanomaterials concentration during the CODA process or any subsequent semester once they join the MSE program.

Curriculum

At NC State, Materials Science and Engineering students are trained to understand the complexities of all classes of material. Our curriculum begins with core courses in thermodynamics, kinetics, and structure, building a strong foundation before advancing to mechanical, thermal, electrical, magnetic, and optical properties.

Hands-on learning is a cornerstone of the program, with two laboratory courses that immerse students in analytical techniques to characterize materials at all scales and measure their properties. Our program covers cutting-edge technologies like nanomaterials, biomaterials, advanced functional materials, materials forensics, computational modeling, and AI-driven materials optimization.

A cornerstone of this concentration is **MSE 465: Nanomaterials**, a specialized course that introduces students to the unique properties and applications of materials at the nanoscale. This course covers the fundamentals of nanostructured materials, including their synthesis, characterization, and integration into various applications. Topics include quantum confinement effects, surface area-to-volume ratios, and the role of nanoscale phenomena in influencing material behavior. To further tailor their education, students select **four electives** from a diverse array of courses in materials processing, engineering, chemistry, physics, and related disciplines. This flexibility allows students to explore topics aligned with their specific interests and career goals. For example, students interested in energy applications might choose electives focusing on nanomaterials for batteries, photovoltaics, or fuel cells, while those aiming

for careers in electronics may explore courses in semiconductor materials or quantum mechanics.

In our two-semester capstone senior design project, students apply their knowledge to solve practical materials challenges with industry partners. Working in teams, you'll tackle hands-on problems and bridge classroom learning with real-world impact.

The Materials Science and Engineering program is accredited by the Engineering Accreditation Commission of ABET (<https://www.abet.org>).

Accelerated Bachelor's/Master's Program

The Accelerated Bachelor's/Master's (ABM) program (<https://www.mse.ncsu.edu/undergraduate/abm/>) gives students the opportunity to earn a bachelor's and a master's degree in five years. Four graduate courses (12 credit hours) can be taken while still an undergraduate student and can be double-counted towards both the bachelor's and master's degrees.

Contact Information

3002 Engineering Building 1 (EB1)
911 Partners Way, Raleigh NC 27695-7907
919.515.2377
Website

Plan Requirements

Code	Title	Hours
Math		
MA 141	Calculus I ^{1,2}	4
MA 241	Calculus II ^{1,2}	4
MA 242	Calculus III ³	4
MA 341	Applied Differential Equations I	3
ST 370	Probability and Statistics for Engineers	3
Sciences		
CH 101 & CH 102	Chemistry - A Molecular Science and General Chemistry Laboratory ^{1,2}	4
CH 201 & CH 202	Chemistry - A Quantitative Science and Quantitative Chemistry Laboratory	4
CH 220 or CH 221	Introductory Organic Chemistry or Organic Chemistry I	3
CH 222	Organic Chemistry I Lab	1
PY 205 & PY 206	Physics for Engineers and Scientists I and Physics for Engineers and Scientists I Laboratory ^{1,2}	4
PY 208 & PY 209	Physics for Engineers and Scientists II and Physics for Engineers and Scientists II Laboratory	4
Economics		
EC 205 or EC 201 or ARE 201	Fundamentals of Economics or Principles of Microeconomics or Introduction to Agricultural & Resource Economics	3
Ethics Elective (verify requirement) (p. 3)		
Required Courses		
MSE 201	Structure and Properties of Engineering Materials ²	3

MSE 255	Experimental Methods for Structural Analysis of Materials	2
MSE 260	Mathematical Methods for Materials Engineers	3
MSE 270	Materials Science and Engineering Seminar	1
MSE 300	Structure of Materials at the Nanoscale	3
MSE 301	Introduction to Thermodynamics of Materials	3
MSE 320	Introduction to Defects in Solids	3
MSE 335	Experimental Methods for Analysis of Material Properties	2
MSE 355	Electrical, Magnetic and Optical Properties of Materials	3
MSE 360	Kinetic Processes in Materials	3
MSE 370	Microstructure of Inorganic Materials	3
MSE 380	Microstructure of Organic Materials	3
MSE 420	Mechanical Properties of Materials	3
MSE 423	Introduction to Materials Engineering Design	1
MSE 470	Materials Science and Engineering Senior Design Project	3
MSE 480	Materials Forensics and Degradation	3
Nanomaterials Concentration Courses		
MSE 465	Introduction to Nanomaterials	3
Nanomaterials Electives (choose 2 courses) (p.)		6
MSE Processing Elective (choose 1 course) (p. 2)		3
Technical Elective (choose 1 course) (p. 3)		3
Technical Writing		
ENG 331	Communication for Engineering and Technology	3
or ENG 333	Communication for Science and Research	
Orientation Course		
E 101	Introduction to Engineering & Problem Solving ^{1,3}	1
E 102	Engineering in the 21st Century ³	2
E 115	Introduction to Computing Environments ¹	1

GEP Courses

ENG 101	Academic Writing and Research ^{1,3}	4
GEP Humanities (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/)		6
GEP Social Sciences (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/)		3
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		2
GEP Elective (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
GEP Interdisciplinary Perspectives (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/)		3
GEP Global Knowledge (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/) (verify requirement)		
GEP Foundations of American Democracy (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-fad/) (verify requirement)		
World Language Proficiency (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/world-language-proficiency/) (verify requirement)		

Total Hours**126**¹ College of Engineering CODA class² Grade of C or higher required³ Grade of C- or higher required**Nanomaterials Electives**

Code	Title	Hours
CH 435	Introduction to Quantum Chemistry	3
CH 437	Physical Chemistry for Engineers	4
CHE 460	Chemical Processing of Electronic Materials	3
CHE 465	Colloidal and Nanoscale Engineering	3
CHE 468/568/ ECE 468/568	Conventional and Emerging Nanomanufacturing Techniques and Their Applications in Nanosystems	3
E 304	Introduction to Nano Science and Technology	3
PY 407	Introduction to Modern Physics	3

Other nanomaterials electives (with departmental approval). Contact your MSE academic advisor for options.

500-level courses (with departmental approval). Available to students who are admitted to an engineering ABM program OR have a minimum 3.5 overall GPA.

MSE Processing Electives

Code	Title	Hours
MSE 440/540	Processing of Metallic Materials	3
MSE 445/545	Ceramic Processing	3
MSE 455/555	Polymer Technology and Engineering	3
MSE 456/556	Composite Materials	3
MSE 460/560	Microelectronic Materials	3

Engineering Electives

Code	Title	Hours
Any MSE processing elective		
CE 214	Engineering Mechanics-Statics	3
CE 225	Mechanics of Solids	3
CSC 110	Computer Science Principles - The Beauty and Joy of Computing	3
CSC 111	Introduction to Computing: Python	3
CSC 113	Introduction to Computing - MATLAB	3
CSC 116	Introduction to Computing - Java	3
ECE 331	Principles of Electrical Engineering	3
ISE 311	Engineering Economic Analysis	3
MAE 206	Engineering Statics	3
MAE 208	Engineering Dynamics	3
MAE 214	Solid Mechanics	3
MSE 485	Biomaterials	3
MSE/ECE/PY 489	Solid State Solar and Thermal Energy Harvesting	3
MSE 409/509/ NE 409/509	Nuclear Materials	3
MSE 490	Special Topics in Materials Science and Engineering	1-4

MSE 495	Materials Engineering Projects (department approval required)	3
NE 202	Radiation Sources, Interaction and Detection	4
TE 205	Analog and Digital Circuits	4

Other engineering electives (with departmental approval). Contact your MSE academic advisor for options.

500-level courses (with departmental approval). Available to students who are admitted to an engineering ABM program OR have a minimum 3.5 overall GPA.

Technical Electives

Code	Title	Hours
Any MSE Processing Elective		
Any Engineering Elective		
BCH 451	Principles of Biochemistry	4
CH 223 & CH 224	Organic Chemistry II and Organic Chemistry II Lab	4
CH 315	Quantitative Analysis	3
CH 401	Systematic Inorganic Chemistry I	3
MA 305	Introductory Linear Algebra and Matrices	3
MA 351	Introduction to Discrete Mathematical Models	3
MA 401	Applied Differential Equations II	3
MA 402	Mathematics of Scientific Computing	3
MA 405	Introduction to Linear Algebra	3
MEA 463	Fluid Physics	3
PY 328	Stellar and Galactic Astrophysics	3
PY 407	Introduction to Modern Physics	3
PY 411/511	Mechanics I	3
PY 412/512	Mechanics II	3
PY 414/514	Electromagnetism I	3
PY 415/515	Electromagnetism II	3

Other technical electives (with departmental approval). Contact your MSE academic advisor for options.

500-level courses (with departmental approval). Available to students who are admitted to an engineering ABM program OR have a minimum 3.5 overall GPA.

Ethics Electives

Code	Title	Hours
EED 414/514	Ethics for Engineering Education	3
IDS 201	Environmental Ethics	3
PHI 214	Issues in Business Ethics	3
PHI 221	Contemporary Moral Issues	3
PHI 227	Data Ethics	3
PHI/STS 325	Bio-Medical Ethics	3
PHI 375	Ethics	3
STS 302	Contemporary Science, Technology and Human Values	3
STS 304	Ethical Dimensions of Progress	3

Semester Sequence

This is a sample.

First Year

Fall Semester		Hours
CH 101 & CH 102	Chemistry - A Molecular Science and General Chemistry Laboratory ^{1,2}	4
ENG 101	Academic Writing and Research ^{1,3}	4
E 102	Engineering in the 21st Century ³	2
MA 141	Calculus I ^{1,2}	4
EC 205 or EC 201 or ARE 201	Fundamentals of Economics or Principles of Microeconomics or Introduction to Agricultural & Resource Economics	3
		Hours 17

Spring Semester

CH 201 & CH 202	Chemistry - A Quantitative Science and Quantitative Chemistry Laboratory	4
E 101	Introduction to Engineering & Problem Solving ^{1,3}	1
E 115	Introduction to Computing Environments ¹	1
MA 241	Calculus II ^{1,2}	4
PY 205 & PY 206	Physics for Engineers and Scientists I and Physics for Engineers and Scientists I Laboratory ^{1,2}	4
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		1
		Hours 15

Second Year

Fall Semester		
MSE 201	Structure and Properties of Engineering Materials ²	3
ST 370	Probability and Statistics for Engineers	3
MA 242	Calculus III ³	4
PY 208 & PY 209	Physics for Engineers and Scientists II and Physics for Engineers and Scientists II Laboratory	4
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		1
		Hours 15

Spring Semester

MSE 255	Experimental Methods for Structural Analysis of Materials	2
MSE 260	Mathematical Methods for Materials Engineers	3
MSE 270	Materials Science and Engineering Seminar	1
CH 220 or CH 221	Introductory Organic Chemistry or Organic Chemistry I	3
CH 222	Organic Chemistry I Lab	1
MA 341	Applied Differential Equations I	3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
		Hours 16

Third Year**Fall Semester**

MSE 300	Structure of Materials at the Nanoscale	3
MSE 301	Introduction to Thermodynamics of Materials	3
MSE 320	Introduction to Defects in Solids	3
MSE 335	Experimental Methods for Analysis of Material Properties	2
Technical Elective (p. 3)		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
Hours		17

Spring Semester

MSE 355	Electrical, Magnetic and Optical Properties of Materials	3
MSE 360	Kinetic Processes in Materials	3
MSE 370	Microstructure of Inorganic Materials	3
MSE 380	Microstructure of Organic Materials	3
Nanomaterials Concentration Elective (p. 2)		3
Hours		15

Fourth Year**Fall Semester**

MSE 420	Mechanical Properties of Materials	3
MSE 423	Introduction to Materials Engineering Design	1
MSE 465	Introduction to Nanomaterials	3
ENG 331 or ENG 333	Communication for Engineering and Technology or Communication for Science and Research	3
MSE Processing Elective (p. 2)		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
Hours		16

Spring Semester

MSE 470	Materials Science and Engineering Senior Design Project	3
MSE 480	Materials Forensics and Degradation	3
Nanomaterials Concentration Elective (p. 2)		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
Ethics Elective (p. 3)GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
Hours		15
Total Hours		126

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Career Opportunities

Earning a Bachelor of Science in MSE: Nanomaterials offers graduates a wealth of exciting career opportunities across diverse industries. The interdisciplinary nature of an MSE education prepares individuals to work

in roles that involve designing, developing, and optimizing materials that drive innovation and address societal needs. Here's what you can expect:

Starting Salary: Graduates in MSE typically earn an average starting salary of \$70,000 to \$90,000 per year.

What can I do with a Nanomaterials Concentration?

A concentration in nanomaterials within MSE offers exciting career opportunities in cutting-edge fields where material properties at the nanoscale are leveraged to revolutionize industries. Nanomaterials professionals are equipped with the expertise to design, characterize, and optimize materials with unique properties like high strength, lightweight, improved electrical conductivity, and enhanced reactivity, making them invaluable in various applications. Whether you aim to pursue a career in research, product development, or environmental sustainability, a concentration in Nanomaterials provides a strong foundation for growth.

Common Industries

- **Advanced Materials & Manufacturing:** Engineer nanostructured metals, ceramics, polymers, and composites for high-performance applications.
- **Electronics & Semiconductors:** Develop nanoscale materials for microchips, sensors, transistors, and quantum computing.
- **Aerospace & Defense:** Enhance lightweight, high-strength materials for aircraft, spacecraft, and protective coatings.
- **Energy & Sustainability:** Create high-efficiency solar cells, next-gen batteries, and hydrogen storage materials.
- **Biomedical & Healthcare:** Design nanoparticles for targeted drug delivery, biosensors, and tissue engineering.
- **Automotive & Transportation:** Improve fuel efficiency, durability, and lightweight materials for electric and conventional vehicles.
- **Pharmaceuticals & Biotechnology:** Innovate in nanomedicine, drug delivery systems, and diagnostic tools.
- **Environmental Engineering:** Engineer nanomaterials for water purification, air filtration, and carbon capture.
- **Consumer Goods:** Develop self-cleaning surfaces, antimicrobial coatings, and high-performance textiles.

Career Titles

- **Nanomaterials Scientist:** Conducting research and development of new nanomaterials for specific applications.
- **Nanotechnology Engineer:** Designing and fabricating nanoscale devices and systems.
- **Quality Assurance Specialist:** Ensuring nanoscale products meet rigorous safety and performance standards.
- **Sustainability Specialist:** Developing nanomaterials for eco-friendly and sustainable solutions

Learn More About Careers

NCCareers.org (<https://nccareers.org/>)

Explore North Carolina's central online resource for students, parents, educators, job seekers and career counselors looking for high quality job and career information.

Occupational Outlook Handbook (<https://www.bls.gov/ooh/>)

Browse the Occupational Outlook Handbook published by the Bureau of Labor Statistics to view state and area employment and wage statistics.

You can also identify and compare similar occupations based on your interests.

Career One Stop Videos (<https://www.careeronestop.org/>)

View videos that provide career details and information on wages, employment trends, skills needed, and more for any occupation. Sponsored by the U.S. Department of Labor.

Focus 2 Career Assessment (<https://careers.dasa.ncsu.edu/explore-careers/career-assessments/>) (NC State student email address required)

This career, major and education planning system is available to current NC State students to learn about how your values, interests, competencies, and personality fit into the NC State majors and your future career. An NC State email address is required to create an account. Make an appointment with your career counselor (<https://careers.dasa.ncsu.edu/about/hours-appointments/>) to discuss the results.

Focus 2 Apply Assessment (<https://www.focus2career.com/Portal/Register.cfm?SID=1929>) (Available to prospective students)

A career assessment tool designed to support prospective students in exploring and choosing the right major and career path based on your unique personality, interests, skills and values. Get started with Focus 2 Apply and see how it can guide your journey at NC State.

American Society for Testing & Materials (<http://www.astm.org/>)

Materials Research Society (<http://www.mrs.org/home/>)

National Society of Professional Engineers (<http://www.nspe.org/>)