AREAS OF CONCENTRATION – class of 2028 and beyond

Materials Science and Engineering

McCormick School of Engineering and Applied Sciences, Northwestern University

Technical Elective Form for the Bachelor of Science Degree

To complete the technical electives requirement for the Bachelor of Science degree, MSE majors choose an area of concentration. If you are not selecting among the courses listed below a pre-approved concentration, you and your advisor may create an original specialization (restrictions apply). Note that some suggested courses will have additional pre-reqs.

Areas of Concentration

Biomaterials

The growth of biotechnology has stimulated interest in the interface of the life sciences and materials science. The field of biomaterials spans three broad areas: biomedical implant materials to replace natural structures; biomimetic materials applying biological concepts to the design of new engineering materials; and the application of materials science principles to the understanding of structure and function in biological systems.

Recommended Courses: MAT_SCI 336, 353, 371; BME 343, 344; CHEM 215-1; CHEM_ENG 275, 372

Design and Manufacturing

This concentration is especially appropriate for those planning a career in industry, where engineers typically work in teams on projects requiring experience with design and manufacturing. It builds on the design content in the materials science curriculum and provides additional interdisciplinary design experience. The concentration also develops industrially relevant strengths in materials selection, computational tools, materials processing, and failure analysis.

Recommended Courses: MAT_SCI 318, 437, 459; DSGN 240, 308, 320, 346, 384-1,-2, 395; ME 240, 315, 327, 328, 340, CIV_ENV 216

Electronic Materials

As microelectronics enters the era of ultralarge-scale integration, materials scientists face new challenges in developing materials and processes for integrated circuits with components of nanometer dimensions. New scientific principles, materials fabrication techniques, and improved instrumentation will be needed to exploit electronic-level structure/property relations in devices and their components. New electronic materials must be developed to meet requirements in a growing range of application areas, such as spintronics, optical computing, and fuel cells.

Recommended Courses: MAT_SCI 353, 357, 358, 382, 385; ELEC_ENG 223, 381, 384, 385; PHYS 352, 357

Energy Materials

Materials play a key role in a variety of energy-related areas including the search for new and efficient energy sources, as well as energy storage and efficient energy utilization. Topics covered in this specialization include fuel cell materials, hydrogen generation and storage, solar energy conversion, lithium-ion battery materials, and light-weight energy efficient structural materials.

Recommended Courses: MAT_SCI 318, 358, 381, 382, 385; CHEM_ENG 345; ME 380

Metals and Ceramics

The ability to design increasingly higher-strength alloys allows for lighter structures and higher-temperature materials provide energy efficiency. Heat-treatable and toughened ceramics exploit advanced knowledge of solid-state phase transformations and reactions. Exciting developments are taking place in high-performance composite combinations of these and other materials for structural and electronic applications.

Recommended Courses: MAT_SCI 340, 345, 358, 360, 371, 382; ME 359, 362, 381, 382, CIV_ENV 216, 321, 323

Nanomaterials

Materials with sizes ranging from 1 to 100 nanometers, are an increasingly important research topic as nanotechnology industries develop. Examples of nanomaterials include ultrahigh-strength materials with nanometer-range structural features and structures designed and self-assembled atom by atom or molecule by molecule. Machines smaller than the tip of a pin can be built using either semiconductor materials processing or biologically inspired processing technology. This specialization is designed to give students the knowledge needed to work at the nanoscale, including design and synthesis, characterization, and theory/modeling/simulation of nanomaterials.

Recommended Courses: MAT_SCI 336, 357, 360, 371, 377; ME 381, 382, 385; CHEM 220, 308; CHEM_ENG 372

Polymeric Materials

Synthetic polymers offer the engineering community an ever-expanding array of materials having properties tailored by chemical and physical processing. New developments are opening up applications for polymers as high-strength, low-weight materials, optoelectronic components, and key materials in other revolutionary areas. The basic understanding of engineering properties, in terms of multilevel microstructure, is essential for the full utilization of polymers.

Recommended Courses: MAT_SCI 336, 371, 377, 431, 437, 445; CHEM 215-1, CHEM_ENG 361

Surface Science

A solid communicates with the outside world through its surface. Wear, corrosion, and passivation are well-known surface processes. Chemical, electronic, and mechanical properties of materials depend on composition at surfaces and grain boundaries (internal surfaces), surface treatments, and the environment. The surface scientist must be able to not only determine the properties of surfaces and interfaces, but also control them.

Recommended Courses: MAT_SCI 345, 360, 380, 444; ME 346

Sustainable Materials

Many technologies in the materials, manufacturing, energy and water sectors that currently provide important benefits to humanity cannot continue indefinitely and must be directed toward a more sustainable path. This concentration focuses on sustainability as applied to materials and the manufacturing processes that are used to convert them into a multitude of different products. It is designed to provide students the knowledge bridging the sustainable materials development and engineering domain with system designs.

Recommended Courses: MAT_SCI 318, 358, 371, 381, 382; ISEN 210, 220; CHEM_ENG 345, 365, 367; ME 359

Other

To be completed with your faculty advisor.

Concentration Planning Workbook

Seven Technical Electives (TEs) are required for your concentration. The courses must be divided as follows:

- Group I: Two 300-level Materials Science and Engineering Classes (excluding 394, 399 and some 395); cannot be taken pass/fail. Group I courses must be partitioned as 100% engineering, excluding some 395 Special Topic Courses. See the ABET Course Partitioning page for details.
- Group II: Five additional* (different) courses with no more than 3 courses at the 200-level (restrictions apply†); no MSE course can be taken pass/fail; only one non-MSE course can be taken pass/fail. Group II must include at least one additional unit that is 100% engineering for a total of three units that are 100% engineering. Only one credit of 399 (or 394) is allowed.[1]

GROUP I Select TWO MAT_SCI Courses		**GROUP II** Select FIVE Additional Courses that are Different from GROUP I			
MAT_SCI 318	MAT_SCI 377	MAT_SCI 318	MAT_SCI 377	CHEM_ENG 345	ELEC_ENG 381
MAT_SCI 336	MAT_SCI 380	MAT_SCI 336	MAT_SCI 380	CHEM_ENG 361	ELEC_ENG 384
MAT_SCI 340	MAT_SCI 381	MAT_SCI 340	MAT_SCI 381	CHEM_ENG 365	ELEC_ENG 385
MAT_SCI 345	MAT_SCI 382	MAT_SCI 345	MAT_SCI 382	CHEM_ENG 367	ME 240
MAT_SCI 353	MAT_SCI 385	MAT_SCI 353	MAT_SCI 385	CHEM_ENG 372	ME 315
MAT_SCI 355	MAT_SCI 395‡	MAT_SCI 355	MAT_SCI 395‡	DSGN 240	ME 327
MAT_SCI 357		MAT_SCI 357	MAT_SCI 399[1]	DSGN 308	ME 328
MAT_SCI 358		MAT_SCI 358	BME 343	DSGN 320	ME 340
MAT_SCI 360		MAT_SCI 360	BME 344	DSGN 346	ME 359
MAT_SCI 371		MAT_SCI 371	CIV_ENV 216	DSGN 384-1	ME 362
MAT_SCI 376		MAT_SCI 376	CIV_ENV 321	DSGN 384-2	ME 381
			CIV_ENV 323	DSGN 395	ME 382
			CHEM_ENG 275	ELEC_ENG 223	ME 385

*If a course you want to apply towards your Concentration is not listed in the table above, list it below:

Catalog Number	Course Title

1. One credit of 399 (or 394) may be applied to group II. However, students should not register for 399 and another research credit (394 honors project or 396 senior project or 596 MS research) concurrently for the same project.

†For Certificate Programs, you must also consider that:

- *ISEN Certificate*: Only ISEN 210 and 220 can be 'double-counted' to fulfill both the Concentration and Certificate requirements. ISEN 230 is not an approved TE.
- *Segal Design Certificate*: Only two DSGN classes can be 'double-counted' and therefore used to fulfill both the Concentration and Certificate requirements

After completing this workbook and discussing with your advisor, fill in and obtain the necessary signatures on the Area of Concentrations Form (next page).

Name: _____ EMPID: _____ Year of Study: _____

Expected Graduation Date: _____

Materials Science and Engineering Area of Concentration Form

Students must complete both sections of this form **by the end of their junior year of study**. If you change your concentration, a new form must be submitted immediately.

Submit this form to the Undergrad Engineering office L269.

Specify your concentration

_____

Specify your course work

- GROUP I: Technical Electives in Materials Science and Engineering (excludes 394, 399 and some 395; cannot be taken pass/fail)

Catalog Number	Course Title	Term

- GROUP II: Technical Electives in Engineering, Natural Sciences, or Mathematics (no MSE course and only one non-MSE course may be taken pass/fail); only one 399 (or 394) allowed.

Catalog Number	Course Title	Term

Student's Signature _____ **Date**

Adviser's Signature _____ **Date**

Assistant Chair's Signature _____ **Date**