AREAS OF CONCENTRATION

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, 370,* 371, 372; BME: 343,* 371; CHEM 210-1; * course duplicates.

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, 341, 355; DSGN 245-1,-2, 308, 320, 346, 384-1,-2, 395; ME, 240, 315, 340, 359

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 337, 355, 357, 358, 376, 382, 398; EECS 250, 385; PHYS 335

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, 333, 337, 358, 376, 381, 382

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 333, 340, 341, 358, 360, 371, 382; ME 365, 381

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 355, 357, 360, 371, 376; ME 381, 382, 385; CHEM 360; PHYS 358

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 333, 336, 337, 370, 371, 372; CHEM 210-1, 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 355, 360, 380, 398; ME 346; PHYS 335

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 312, 365, 367/ME 367 (co-listed); ME 359

Other

To be completed with your faculty advisor.

Concentration Planning Workbook

Five 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 II: Three additional* (different) courses with no more than 2 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. Only one 399 is allowed.[1]

GROUP I Select TWO MAT_SCI Courses		**GROUP II** Select THREE Additional Courses that are Different from GROUP I			
MAT_SCI 318	MAT_SCI 362	MAT_SCI 318	MAT_SCI 372	CHEM 360	EECS 250
MAT_SCI 333	MAT_SCI 370	MAT_SCI 333	MAT_SCI 376	CHEM_ENG 312	ESAM 311-1
MAT_SCI 336	MAT_SCI 371	MAT_SCI 336	MAT_SCI 380	CHEM_ENG 361	ESAM 311-2
MAT_SCI 337	MAT_SCI 372	MAT_SCI 337	MAT_SCI 381	CHEM_ENG 365	ISEN 210
MAT_SCI 340	MAT_SCI 376	MAT_SCI 340	MAT_SCI 390	CHEM_ENG 367/ME 367	ISEN 220
MAT_SCI 341	MAT_SCI 380	MAT_SCI 341	MAT_SCI 394	DSGN 241-1 and -2	ME 340
MAT_SCI 355	MAT_SCI 381	MAT_SCI 355	MAT_SCI 395	DSGN 308	ME 346
MAT_SCI 357	MAT_SCI 382	MAT_SCI 357	MAT_SCI 398	DSGN 320	ME 359
MAT_SCI 358	MAT_SCI 398	MAT_SCI 358	MAT_SCI 399[1]	DSGN 346	ME 381
MAT_SCI 360	MAT_SCI 395‡	MAT_SCI 360	BIO 215	DSGN 384-1	ME 382
		MAT_SCI 362	BME 343	DSGN 384-2	ME 385
		MAT_SCI 370	BME 371	DSGN 395	PHYS 335
		MAT_SCI 371	CHEM 210-1	EARTH 201	PHYS 358

*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
- ‡ Group I courses must be partitioned as 100% engineering, excluding some 395 Special Topic Courses.

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**