EP.06.05
(Rev. 11/14/05)

PROPOSAL TO THE SENATE COMMITTEE ON EDUCATIONAL POLICY

TITLE OF THE PROPOSAL: Revision and increase in hours of the BS degree in Materials Science and Engineering, College of Engineering.

SPONSOR: Professor Phillip H. Geil, Associate Head, Department of Materials Science and Engineering, 217-333-0149, geil@uiuc.edu

BRIEF DESCRIPTION: It is proposed to increase the laboratory experience for students in the MatSE Biomaterials concentration, requiring an increase in total hours for the MatSE BS degree from 128 to 131 hours. The following specific changes are proposed:

1. MSE 472 (Biomaterials Laboratory) be increased from 1 to 3 hours, required for Biomaterials concentration students (see Appendix I)
2. MCB 150, required for the Biomaterials concentration and previously counted as 3 hours toward the degree, is increased to the correct 4 hours.
3. A 3 hour "breadth" technical elective be added to the curricula for the other MatSE concentrations.
4. The total hours required for graduation, to accommodate the above changes, are increased from 128 to 131 hours.

Details of the new curricula are included in the Statement for Programs of Study Catalog.

JUSTIFICATION:

1. With the addition of staff and equipment, the department is now able to offer an excellent 3 hour Biomaterials lab as compared to the current 1 hour laboratory course (a brief outline is attached as Appendix 1). The increase to 3 hours will make it equivalent to the hours for the senior labs in the other concentrations (Ceramics, Electronic Materials, Metals, and Polymers).
2. MCB 150, a required course for the Biomaterials concentration is 4 hours rather than 3 hours as counted toward the degree in the current curriculum. We thought we had an agreement that MatSE students could register for 3 hours, not participating in the Discussion sections; it turns out this was impossible due to the approved nature of the course.
3. Since there are no remaining courses in the Biomaterials curriculum that can be dropped and retain the needed courses in both materials and biology, we propose to raise the total hours for the BS degree to 131; 2 extra hours for the lab and 1 for MCB 150. We note that the recently approved Bioengineering BS curriculum requires a total of 132 hours; the "excess hours" being needed to include necessary Biology and Engineering courses.
4. In order to increase the MatSE breadth of the students in the non-biomaterials concentrations, they will be required to take a 3 hour "breadth" technical elective course in one of the other MatSE areas; these can be selected from the list of area specialty courses. Biomaterials area students are already required to take 2 such courses. Adding this requirement for the non-biomaterials students maintains the consistency of total hours required for all students and broadens their materials background.

BUDGETARY AND STAFF IMPLICATIONS: The department has obtained much of the needed equipment for the new lab from alumni donations; all needed equipment and space for the currently planned experiments are available. We have also hired a staff person to teach the lab; previously it was an overload for one of our faculty in biomaterials who has recently transferred (75%) to Bioengineering. Students in the added area specialty course can easily be accommodated in current courses. Thus the effect on any single course, in and out of the department, will be minimal.

GUIDELINES FOR UNDERGRADUATE EDUCATION: The change in the biomaterials curriculum will have a significant impact on the experimental abilities and experiences of the students. The increase in hours for students in the other areas will permit them to broaden their background.

PROPOSED EFFECTIVE DATE: Fall 2005

CLEARANCES:

_____ Date: 30 Sept 2005
Department of Materials Science and Engineering

_____ Date: 10/03/05
College of Engineering

_____ Date_____
Office of the Provost

STATEMENT FOR THE PROGRAM OF STUDY CATALOG

For the Degree of Bachelor of Science in Materials Science and Engineering

Materials are the basis for all Engineering. Improvements in the quality of life require knowledge of the processing and properties of current materials and the design, development and application of new materials; i.e., Materials Science and Engineering. The Materials Science and Engineering curriculum provides the student with an understanding of the underlying principles of synthesis and processing of materials and of the interrelationships between structure, properties, and processing. Students learn how to design advanced materials ranging from better polymers for synthetic fabrics and ceramic-metal composites for jet engines, to advanced ceramic thin films for microelectronics and biocompatible materials for implants in the body. The curriculum uses concepts from both basic physics and chemistry and provides a detailed knowledge of what makes the materials we use every day respond as they do.

Students in the first two years take courses in general areas of science and engineering as well as courses introducing the concepts in MatSE. The curriculum is designed to allow relatively easy transfer to and from other engineering disciplines within the first two years. In the third year, students study the common, central issues related to MatSE. Seniors focus on application areas of MatSE (e.g., biomaterials, ceramics, metals, polymers, and electronic materials), which provide them with the detailed knowledge to be immediately useful to corporations or to provide an introduction to graduate study.

This degree program is designed to be completed in eight semesters of study with no advanced placement (AP or IB) credit. The MatSE degree requires a minimum of 131 hours for graduation and is consistent with the professional component described in the introduction for the college. The program is ABET accredited. Formal statements of the mission of the department and the goals of the undergraduate program as well as further details may be found at the department website.

Areas of Concentration

The MatSE program provides five standard areas of concentrations as well as the option to design unique programs of interest to the student. Students are encouraged to take technical electives outside of the department in related disciplines of interest to them and of relevance to their career goals.

- **Biomaterials:** A new focus area teaching the science and engineering of materials for use in biological applications, particularly in the human body. This concentration uses a strong focus on basic and intermediate chemistry along with basic and intermediate biology concepts, with relatively little use of physics topics. This focus area includes a subset of the standard junior year courses and requires additional chemistry and biology in the junior year.

- **Ceramics:** Students study the science and engineering of ceramic materials, including alloy design, composites, synthesis, and processing methods. This concentration makes significant use of concepts from both basic physics and basic chemistry.

- **Electronic Materials:** Describes the design and engineering of materials primarily for the microelectronics industries. Topics span the ceramics, metals, and polymers areas. Concepts from basic and intermediate physics are used along with basic chemistry.

- **Metals:** Introduces the design and processing of metals and alloys to achieve desired properties. This concentration primarily uses concepts from basic and intermediate physics with relatively less emphasis on chemical concepts.

- **Polymers:** Teaches the methods for molecular design to achieve desired properties in polymer molecules and polymer blends as well as processing methods. This concentration primarily uses concepts from basic and intermediate chemistry with relatively less emphasis on physics concepts.

Educational Objectives

The educational objectives of the MatSE Department are

- To provide the foundation for entry-level industrial positions in materials-related industries or advanced study programs through in-depth instruction in both materials as a whole and in their chosen concentration. An emphasis is placed on analysis, problem solving, open-ended problems, and materials design methods.
- To develop teamwork, communication skills, and individual professionalism, including ethics and environmental awareness.
- To encourage students to broaden their education in engineering and science or expand their knowledge through student-selected technical and free electives and cooperative engineering education, internship, and study abroad programs.
- To teach students to learn and grow as individuals, contribute to society, and to develop life-long learning and leadership skills.

Educational Outcomes

It is expected that the graduates will have an ability to

- apply knowledge of mathematics, science, and engineering to materials topics,
- formulate engineering and science problems and develop practical solutions, hypotheses, and experimental methods,
- design materials products, components, and processes,
- design, conduct, analyze, and interpret results of experiments,
- work effectively in multidisciplinary teams and provide leadership,

- achieve effective oral, graphic, and written communication,
- understand the impact of science and engineering decisions in a global, societal, economic, and environmental context,
- understand legal, professional and ethical responsibility,
- recognize the value of and carry out life-long learning,
- understand contemporary issues and contribute effectively,
- use the techniques, skills, and modern tools necessary for materials engineering and science practice,
- make a responsible contribution to society,
- be familiar with chemistry, physics, and advanced mathematics.

Working in MatSE

MatSE graduates work with engineers across the spectrum of design and manufacturing. They design the materials that make the technologies we rely on work better. Our graduates work as part of teams designing high-technology devices. They move on to management. They get advanced degrees and work as teachers and bench scientists.

Job Opportunities

Because advanced materials pervade all aspects of our society, MatSE students are found working in all areas. MatSE graduates work for all types of engineering and technology companies, ranging from small businesses to huge corporations. Starting salaries are among the highest in engineering. MatSE graduates work for microelectronics companies; automotive, aircraft, space, and other vehicle manufacturers; chemical, metal, glass, and other materials manufacturing industries; and many others. All companies that manufacture mechanical, electronic, or other devices can benefit from staff members with a strong understanding of materials. MatSE students also go on to graduate school in science, engineering, medicine, and business.

Suggested Sequence

The first two years of the Suggested Sequence is the same for all MatSE students. The third and fourth years vary with the Area of Concentration chosen. Refer to the appropriate third and fourth year sequence.

First year

Hours	First Semester
3	CHEM 102—General Chemistry I
1	CHEM 103—General Chemistry Lab I
0	ENG 100—Engineering Lecture
5	MATH 220—Calculus I
3	MSE 182—Intro to Materials Sci and Eng
4-3	RHET 105—Principles of Composition[1] or elective in social sciences or humanities[2]
16-15	Total

Hours	Second Semester
3	CHEM 104—General Chemistry II
1	CHEM 105—General Chemistry Lab II
2	MATH 225—Introductory Matrix Theory
3	MATH 230—Calculus II
(1)	MSE 100—Materials Lecture[3]
4	PHYS 211—Univ Physics, Mechanics
3-4	Elective in social sciences or humanities[2] or RHET 105—Principles of Composition[1]
16-17	Total

Second year

Hours	First Semester
3	CS 101—Intro to Computing, Eng & Sci
3	MATH 242—Calculus of Several Variables
3	MSE 201—Phases and Phase Relations
4	PHYS 212—Univ Physics, Elec & Mag
3	Elective in social sciences or humanities[2]
16	Total

Hours	Second Semester
3	ECE 205—Intro Elec & Electr Circuits
3	MATH 385—Intro Differential Equations
2	PHYS 214—Univ Physics, Quantum Phys
4	TAM 206—Mechanics for MatSE
3	Elective in social sciences or humanities[2]
15	Total

Concentrations in Ceramics, Electronic Materials, Metals, and Polymers

Third year

Hours	First Semester
3	IE 300—Analysis of Data
3	MSE 307—Materials Laboratory, I[4]
4	MSE 401/CHEM 484—Thermodynamics of Materials
3	MSE 406—Thermal-Mech Behavior Matls
3	Elective in social sciences or humanities[2]
16	Total

Hours	Second Semester
3	MSE 304—Electronic Properties of Matls
3	MSE 308—Materials Laboratory, II[4]
3	MSE 402—Kinetic Processes in Materials
3	MSE 405—Microstructure Determination
3	Area specialty course[5]
3	Free elective
18	Total

Fourth year[6]

Hours	First Semester
	MSE 403—Synthesis of Materials, or CHEM 232—Elementary Organic Chemistry I
6	Area specialty courses[5]
3	Technical elective[7]
3	Elective in social sciences or humanities[2]
3	Area specialty course in a different area[5]
18	Total

Hours	Second Semester
1	MSE 395—Materials Design
6	Area specialty courses[5]
3	Technical elective[7]
3	Elective in social sciences or humanities[2]
3	Free elective
16	Total

Concentration in Biomaterials

Third Year

Hours	First Semester
3	CHEM 232—Elementary Organic Chemistry I
3	IE 300—Analysis of Data
3	MSE 307—Materials Laboratory, I[4]
4	MSE 401/CHEM 484—Thermodynamics of Materials
3	MSE 406—Thermal-Mech Behavior Matls
16	Total

Hours	Second Semester
4	MCB 150—Molec & Cellular Basis of Life
3	MCB 450—Introductory Biochemistry
3	MSE 308—Materials Laboratory, II[4]
3	MSE 402—Kinetic Processes in Materials
3	Elective in social sciences or humanities[2]
16	Total

Fourth year[6]

Hours	First Semester
9	Area specialty courses[5]
3	Area specialty course in a different area [5,8]
3	Elective in social sciences or humanities[2]
3	Free elective
18	Total

Hours	Second Semester
3	MCB 252—Cells, Tissues & Development
1	MSE 395—Materials Design
5	Area specialty courses[5]

3	Area specialty course in a different area [5,8]
3	Elective in social sciences or humanities[2]
3	Free elective
18	Total

1. RHET 105 may be taken in the first or second semester as authorized. The alternative is a social science or humanities elective.

2. Each student must satisfy the 18-hour social sciences and humanities requirements of the College of Engineering and the campus general education requirements for social sciences and humanities.

3. This course is highly recommended for freshmen, who may use it to help meet free elective requirements.

4. Satisfies the General Education Advanced Composition requirement.

5. To be selected from the list of area specialty courses as established by the department to provide an acceptable level of study in the student's chosen area of concentration.

6. It is recommended that students who intend to continue in graduate school undertake a research project in the senior year. The project may take the place of 4-6 hours of free, technical, or area technical (specialty) electives.

7. Selected from the departmental list of approved technical electives.

8. Both area specialty courses in this category must be from one of the other MatSE areas of concentration.

Area Specialty Courses

The courses listed below have been approved by the department to satisfy the 14-15 credit hour requirements in each of the five areas of technical concentration.

Hours	Biomaterials Concentration
3	MSE 470— Design and Use of Biomaterials
3	MSE 472— Biomaterials Laboratory
3	MSE 473— Biomolecular Materials Science
5	Two area technical electives[1]

Hours	Ceramics Concentration
3	MSE 420—Ceramic Matls and Properties
3	MSE 421—Cer Proc & Microstruc Devel
3	MSE 423—Ceramic Processing Laboratory
3	MSE 422—Electrical Ceramics
3	Area technical elective[1]

Hours	Electronic Materials Concentration
3	ECE 440—Solid State Electronic Devices
3	MSE 460—Electronic Matls & Proc, I
3	MSE 461—Electronic Matls & Proc, II
3	MSE 462—Electronic Materials Lab
3	Area technical elective[1]

Hours	Metals Concentration
3	MSE 440—Adv Mechanical Prop of Solids
3	MSE 441—Metals Processing
3	MSE 442—Metals Laboratory
3	MSE 443—Design of Engineering Alloys
3	Area technical elective[1]

Hours	Polymers Concentration
3	MSE 450—Intro to Polymer Sci and Eng
3	MSE 452—Polymer Laboratory
3	MSE 453—Plastics Engineering
6	Two area technical electives[1]

1. Selected from the departmental list of approved technical electives for areas of concentration.

Summary of Topics Courses for Areas of Concentration

Each area of concentration requires at least one course covering each of the topics processing, design, and characterization (senior lab). For the five standard areas of concentration in the MatSE curriculum outlined above, the relevant courses are categorized in the following table.

Area Specialty	Processing	Design	Characterization (Senior Lab)
Biomaterials	MSE 470*	MSE 470*	MSE 472
Ceramics	MSE 421	MSE 422	MSE 423
Electronic Materials	MSE 460	MSE 461	MSE 462
Metals	MSE 441	MSE 443	MSE 442
Polymers	MSE 453*	MSE 453*	MSE 452

*same course counts as both topics

Customized Areas of Specialization

Students wishing to pursue areas of specialization other than areas of concentration described above should consult with the chief advisor of the MatSE department. In fashioning a customized area of specialization, it must total 15 credit hours and there must be a course identified for each of the topic categories in the table immediately above. The other courses may be suitable electives pertaining to the area of specialization. Customized areas of specialization require the approval of the department and the area of specialization will not be listed on the transcript

Appendix I

MSE 472 (revised)

Course description:
Experimental topics cover chemistry and physics of biomaterials, biocompatibility of materials, tissue re-generation, rheology of biomaterials and tissues, structural studies of biomaterials, and controlled release of small molecules and drugs. Laboratory techniques include protein purification, cytotoxicity testing, tissue culture, mechanical testing, microscopy, and X-ray diffraction. Prerequisites: MSE 470 or consent of instructor. 3 hours

Proposed Syllabus for Biomaterials Laboratory (MSE 472)

Tentative Weekly Schedule

Week	Activities
1	Introduction Collagen purification I: rat tail dissection; extraction; salt precipitation; dialysis
2	Collagen purification II: anion-exchange chromatography; electrophoresis; collagen gel reconstitution
3	Biocompatibility I: introduction to tissue culture (video); aseptic technique practice; autoclave; cell splitting; library work
4	Biocompatibility II: maintenance of cell culture; direction contact method
5	Biocompatibility III: Elution method; agar diffusion method
6	Biomaterials testing I: stress-strain measurements of soft materials and tissues
7	Biomaterials testing II: compression of hard materials and tissues
8	Structure of biomaterials: X-ray diffraction
9	Tissue regeneration I: scaffold fabrication; seeding cells on scaffold materials
10	Tissue regeneration II: observation of cell growth
11	Tissue regeneration III: determination of tissue regeneration
12	Controlled Release I: controlled release materials
13	Controlled Release II: controlled release observation by spectroscopy
14	Final (practicals): electrophoresis; cell passage and cell counting; shear stress measurement of reconstituted collagen gels

Course texts

- Biomaterials Science: An Introduction to Materials in Medicine (Edited by Ratner et al., 2nd Edition), Granger Library.
- Lecture notes