



DEPARTMENT OF
MATERIALS SCIENCE
AND ENGINEERING

201 DuPont Hall
University of Delaware
Newark, Delaware 19716-3106
Ph: 302/831-2062
Fax: 302/831-4545
Email: matsci@udel.edu

To: Prof. Michael Keefe, Chair
Educational Activities Committee
The College of Engineering
The University of Delaware

Date: November 17, 2009

Re: 4+1 degrees in Materials Science and Engineering (MSEG)

From: David C. Martin, Karl W. and Renate Böer Professor and Chair
Materials Science and Engineering
milty@udel.edu
(302) 831-2062

A handwritten signature in black ink, appearing to be "D. C. Martin".

The 4+1 BSE/MMSE program provides for undergraduate students at the University of Delaware to obtain a Master's Degree in a shorter time after their undergraduate degree by allowing for the double-counting of up to 6 credits of undergraduate course work toward their graduate degree. The 4+1 program is an attractive means for providing advanced educational training options for students, and for encouraging Delaware students to stay in Newark for graduate school.

The Materials Science and Engineering Department at Delaware (<http://www.mseg.udel.edu/>) provides an ideal opportunity for students in partnering departments to obtain an advanced graduate degree. The purpose of this memo is to request approval for the initiation of 4+1 Master's Degrees in Materials Science and Engineering (MMSE). We expect most of the MSEG 4+1 students to come from Chemical Engineering and Mechanical Engineering, although we would like to welcome them from Electrical Engineering and Civil and Environmental Engineering as well. We also believe there will be interest from students in the Arts and Sciences College, specifically from Chemistry, Physics, and Biology.

The faculty of MSEG formally approved the adoption of the MMSE 4+1 option at its faculty meeting on October 27, 2009.

UNIVERSITY FACULTY SENATE FORMS

Academic Program Approval

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. For more information, call the Faculty Senate Office at 831-2921.

Submitted by: ___David C. Martin ___ phone number ___X2062_____

Department: ___Materials Science and Engineering___ email address ___milty@udel.edu

Date: _____10/29/09_____

Action: ___add a new 4+1 BSE/MMSE degree in Materials Science and Engineering___
(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc)

Effective term _____10F_____ (use format 04F, 05W)

Current degree _____MMSE_____ (Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc)

Proposed change leads to the degree of: _____MMSE (no change)_____ (Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc)

Proposed name: _____4+1 BSE/MMSE_____ Proposed new name for revised or new major / minor / concentration / academic unit (if applicable)

Revising or Deleting:

Undergraduate major / Concentration: _____ (Example: Applied Music – Instrumental degree BMAS)

Undergraduate minor: _____ (Example: African Studies, Business Administration, English, Leadership, etc)

Graduate Program Policy statement change: _____ (Must attach your Graduate Program Policy Statement)

Graduate Program of Study: _____ (Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

Graduate minor / concentration: _____

Note: all graduate studies proposals must include an electronic copy of the Graduate Program Policy Document, highlighting the changes made to the original policy document.

Attached

List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?

(Be aware that approval of the curriculum is dependent upon these courses successfully passing through the Course Challenge list. If there are no new courses enter "None")

None

Explain, when appropriate, how this new/revised curriculum supports the 10 goals of undergraduate education: <http://www.ugs.udel.edu/gened/>

NA

Identify other units affected by the proposed changes:

(Attach permission from the affected units. If no other unit is affected, enter "None")

None

Describe the rationale for the proposed program change(s):

(Explain your reasons for creating, revising, or deleting the curriculum or program.)


Currently, the Materials Science and Engineering Department offers an MMSE (Masters of Materials Science and Engineering) as a non-thesis master's degree. This degree is offered primarily as a part-time, professional master's degree program for working professionals. In an effort to expand our graduate student enrollment at the master's degree level (consistent with University strategic plan), we propose to include full-time students in this program as well. The proposed 4+1 BSE/MMSE program will give highly qualified and motivated undergraduates from a number of different departments in the College of Engineering (Chemical, Mechanical, Electrical and Computer, and Civil and Environmental) as well as from the College of Arts and Sciences (Biology, Chemistry, Physics) a chance to earn both a BS and an MMSE degree in five years of full-time study.


Program Requirements:


(Show the new or revised curriculum as it should appear in the Course Catalog. If this is a revision, be sure to indicate the changes being made to the current curriculum and **include a side-by-side comparison** of the credit distribution before and after the proposed change.)

No changes to requirements of current undergraduate or graduate degrees. However will allow six credits of the required MSEG6XX courses that were counted as electives in the undergraduate program to also count toward the graduate degree.

ROUTING AND AUTHORIZATION: (Please do not remove supporting documentation.)

Department Chairperson  Date 11/17/09

Dean of College  Date 11/18/09

Chairperson, College Curriculum Committee  Date 11/23/09

Chairperson, Senate Com. on UG or GR Studies _____ Date _____

Chairperson, Senate Coordinating Com _____ Date _____

Secretary, Faculty Senate _____ Date _____

Date of Senate Resolution _____ Date to be Effective _____

Registrar _____ Program Code _____ Date _____

Vice Provost for Academic Affairs & International Programs _____ Date _____

Provost _____ Date _____

Board of Trustee Notification _____ Date _____

GRADUATE PROGRAM

Materials Science and Engineering

ADMISSION TO PROGRAM

Students are admitted into the graduate program for either a Master's or a doctoral, Ph.D., degree. For students with a bachelor's degree the following minimum criteria will normally be applied:

1. A baccalaureate degree in mechanical engineering or in a closely related field of science or mathematics.
2. An undergraduate grade point average in engineering, science and mathematics courses of at least 3.0 on a 4.0 scale.
3. A minimum of at least three letters of strong support from former teachers or supervisors.
4. A minimum combined Quantitative and Verbal score of 1200 in the Graduate Record Examination Aptitude Test.
5. A minimum score of 600 (or IBT equivalent) in the Test of English as a Foreign Language for students whose first language is not English. This test is not required of students whose first language is English and who have received an undergraduate or post-graduate degree from a College or University in which English is the sole language of instruction.

Admission with financial aid is granted on a competitive basis; therefore, satisfaction of the above minimum standards does not guarantee admission. All admissions require approval of the Office of Graduate Studies.

For applicants with no prior training in engineering, the same minimum criteria will apply. In addition, their records will be reviewed in relation to the intended program of study. Provisional status with specific remedial work may be a basis for acceptance of such applicants. The acceptance of applicants who have already received a Master's degree in engineering will be based on the above minimum criteria and the results of their graduate work.

ADMISSION TO THE 4+1 BSE/MMSE PROGRAM

The department offers a special 4+1 BSE/MMSE program for highly-qualified undergraduate students from the University of Delaware. This program allows the student to earn both a BS in one of several partnering departments (including Chemical Engineering, Mechanical Engineering, Electrical and Computer Engineering, and Civil and Environmental Engineering in the College of Engineering, and Biology, Chemistry, and Physics in the College of Arts and Sciences) and the MMSE degree in 5 years of full-time study at the University of Delaware. Students would normally apply in the spring of their junior year. For admission to this program the following minimum criteria will be applied:

1. An undergraduate grade point average of at least 3.2 on a 4.0 scale at the end of their junior year.
2. A minimum of two letters of support from professors at the University of Delaware.

ADVISEMENT

A temporary academic advisor is assigned to new students when they are admitted to the Department. Students select their permanent advisor once they become familiar with the department, and clear about their research interests. The permanent advisor will be someone whose interest matches the interest of the student insofar as possible. For students on Research Assistantships, the advisor directs their research and advises them on course selection.

Masters in Materials Science and Engineering (MMSE) Program Requirements

Two options are available, one with a thesis and the other by lecture course credit only. The first is available to all students, the second is only available to Outreach or part-time students and does not require a thesis. Transfer is not permitted from the first to the second option, although transfer is acceptable from the second to the first.

MMSE with Thesis

Coursework

24 credit hours of course work and 6 credit hours of thesis research are necessary for the thesis-option Master's degree.

The following 3 credit courses, or their equivalent as approved by the faculty advisor and Chairperson, are required:

MSEG 803 Equilibria in Materials Systems

MSEG 804 Kinetics in Materials Systems

MSEG 602 Structure of Materials

MSEG 607 Physical Properties of Materials I

MSEG 630 Introduction to Polymer Science and Engineering

The remaining 15 credits of elective courses will be chosen after discussion with the advisor, and will usually be related to the student's area of research interest.

Thesis

Six credit hours of thesis work must be completed, and the thesis must be accepted by both the research advisor and the Chairperson of the Materials Science and Engineering Faculty. A formal defense of the Master's thesis before the committee may be required.

Thesis advisors and graduate student advisory committees will be appointed by the Materials Science and Engineering Faculty after discussions with the student and his/her advisor. Changes in advisor or advisory committee are made either by informal agreement (the usual policy) or by action of the Materials Science and Engineering Faculty in which final authority in all such matters resides.

MMSE without Thesis

30 credit hours of lecture course work are necessary for the Master's degree without thesis.

The following 3 credit courses, or their equivalent as approved by the faculty advisor and Chairperson, are required:

MSEG 803 Equilibria in Materials Systems

MSEG 804 Kinetics in Materials Systems

MSEG 602 Structure of Materials

MSEG 607 Physical Properties of Materials I

MSEG 630 Introduction to Polymer Science and Engineering

The remaining 15 credits of elective courses will be chosen after discussion with the advisor, and will usually be related to the student's area of interests.

4+1 BSE/MMSE PROGRAM

Students admitted to the 4+1 BSE/MMSE program must meet all the above requirements for the

MMSE degree. However, these students are required to complete two of the required courses during enrollment in the BS degree. These two courses can also be counted toward meeting the technical elective requirements of the respective BS degree.

4+1 BSE/MMSE DEGREE in MATERIALS SCIENCE AND ENGINEERING (MSEG) AT THE UNIVERSITY OF DELAWARE

QUESTIONS & ANSWERS

The following are answers to commonly asked questions about the Materials Science and Engineering (MSEG) 4+1 BSE/MMSE Degrees at the University of Delaware. Feel free to contact Dionne Putney, MSEG Office Manager, or Prof. David C. Martin, Chair of Materials Science and Engineering, if you have additional questions.

Materials Science and Engineering
201 DuPont Hall
Newark, DE 19716

Telephone: (302) 831-2062
Email: dionner@udel.edu

GENERAL INFORMATION

What are MSEG 4+1 BSE/MMSE Degrees?

Students in the MSEG 4+1 BSE/MMSE program are allowed to satisfy some of the requirements for an MSEG MMSE (Masters in Materials Science and Engineering) degree while completing the requirements for the B.S. degree. A maximum of six hours of credit can be used for both degrees.

What are the advantages of the MSEG 4+1 BSE/MMSE program?

Many employers now favor hiring more highly trained engineers at

the entry level of the profession. Many in the academic community feel that a combined bachelor/master's program will soon become the accepted standard training for engineers. The MSEG 4+1 BSE/MMSE program is an integrated program that facilitates the completion of a master's degree with two semesters of study beyond that required for the bachelor's degree. Up to six hours of required course work can be double counted within the combined program. Thus, with proper planning and scheduling, a semester of study may be eliminated and students should be able to complete the B.S. and M.S. degrees with five years of study. Upon completion of the SGUS program students have all the job possibilities available with their traditional engineering or science degree as well as the additional possibilities created with a M.S. degree in Materials Science and Engineering.

What are the disadvantages of the MSEG 4+1 BSE/MMSE program?

4+1 BSE/MMSE status may impact negatively on the eligibility for undergraduate and graduate financial aid. The time-saving advantage of the 4+1 BSE/MMSE program may be lost if the student does not follow an efficient plan of study when they enter the program.

Why get a Master's degree?

Engineering is fast becoming a field where a master's degree is of increasing importance for professional development. This degree is also a way to round out and enhance the knowledge gained by the undergraduate experience and to provide specific knowledge in a niche area of engineering. A master's degree is also a necessary first step toward a Ph.D. degree.

When is the best time to get a Master's degree?

The best time will depend on personal goals and plans. There are several paths to the Master's degree including continuation

immediately after the Bachelor's degree, part-time education in conjunction with employment, and a delayed return to the University after field experience. Students should choose the route that fits with their individual career goals and lifestyle choices.

Can I get Financial Support for MSEG 4+1 BSE/MMSE Degrees?

Generally, no, at least not from the MSEG Department itself. It is not anticipated that Graduate students enrolled in the MSEG 4+1 BSE/MMSE program will be awarded additional financial support by the MSEG Department. Students are however actively encouraged to explore the possibility of secure fellowships from such institutions as the NSF or DOD. Students are also encouraged to consider continuing on for a Ph.D., where financial assistance is often readily available.

What courses can I use to satisfy the requirements of both degrees?

You may substitute any course that meets the requirements of both programs. In general, this will correspond to any senior level courses or above (courses numbered 400 or higher) taken in the undergraduate department. According to the 4+1 BSE/MMSE guidelines, courses that are required to be taken as part of the core undergraduate program are not typically allowed to be double counted. However this can vary by department. In all cases students are advised to discuss their course selection with both the undergraduate and graduate advisors early and often.

Does this change the requirements for my undergraduate degree?

No, you still need to take all of the classes required for the undergraduate degree. The double counted classes will be those that

are technical electives for the undergraduate degree. Classes that are specifically required for the undergraduate degree itself are not appropriate for double counting.

Can I get an MSEG 4+1 BSE/MMSE degree if I am an undergraduate in the Arts & Sciences College?

We expect that most of the MSEG 4+1 BSE/MMSE students will come from undergraduate programs in the College of Engineering, and most likely these will be primarily from Chemical Engineering and Mechanical Engineering. However we also anticipate and hope that students from Electrical and Computer Engineering as well as Civil and Environmental Engineering will find this a valuable option. We are also expecting that there will be students who choose to pursue the MSEG 4+1 BSE/MMSE degree after a degree from Arts & Sciences. This degree would likely make an excellent compliment to undergraduate students from Physics, Chemistry, and perhaps Biology.

Will I need to pick a MSEG concentration option?

Yes. Each graduate student in MSEG is required to choose a particular technical option that determines the specific course requirements. Currently, the approved options include Soft Materials, Hard Materials, and Composites. The specific course requirements vary depending on the particular option, as described in detail later in this document and on the MSEG web pages. An individualized option is also available with the permission of the MSEG Chair and the MSEG Graduate Program Director.

APPLICATION INFORMATION

Who can apply?

To officially enter the MSEG 4+1 BSE/MMSE program a student must:

- * Have obtained senior standing (85+ hours) by the time of entry
- * Have a GPA of 3.2 or above
- * Be enrolled in one of the following undergraduate programs: In the College of Engineering: Chemical Engineering, Electrical Engineering and Computer Science, Civil Engineering, or Mechanical Engineering. In the College of Arts and Sciences: Chemistry, Physics, or Biology.

How does one apply?

First, make an appointment with the MSEG Graduate Chair Kristi Kiick, to discuss this program and ensure that it is a good fit with your career goals and plans.

Then, fill out an application for the Graduate School, writing '4+1' in the upper right hand corner. The application is submitted to the UDel Graduate School. The statement of purpose, transcripts (needed for courses taken at other universities) and three recommendation letters should be submitted directly to the MSEG Department. General Record Exam (GRE) scores are not required. The graduate school application fee must be submitted as well.

When should one apply?

The application deadlines are:

To begin MSEG 4+1 BSE/MMSE in fall term- U.S. & Canadian students apply by August 1, International students apply by June 1

To begin MSEG 4+1 BSE/MMSE in spring term- U.S. & Canadian students apply by Nov. 1, International students apply by October 1

In the Winter and Summer terms, very few course offerings are available. Most students will be better served by entering the program in the Fall or Spring terms.

Is my admission automatic if I meet the basic criteria (GPA and senior standing)?

Admission is not automatic. Your application will be carefully reviewed by the MSEG faculty. Your statement of purpose and letters of recommendation are important parts of the admission decision.

Are GRE's required for 4+1 BSE/MMSE?

GRE scores are not required for admission to the 4+1 BSE/MMSE program, but are required for admission to the regular MSEG Masters and Ph.D. programs. If a student is seriously considering pursuing a Ph.D., the GRE test should be taken during the senior year. This also facilitates applications for major national graduate fellowships from the National Science Foundation, the Office of Naval Research, the Department of Energy, and others.

Must international students retake the Test of English as a Foreign Language (TOEFL) for admission to the MSEG 4+1 BSE/MMSE?

The TOEFL is waived for students who have already taken it.

How can I become involved in the MSEG 4+1 BSE/MMSE program before I reach senior standing?

Students who are interested in the MSEG 4+1 BSE/MMSE program can begin to follow the recommended curriculum for their particular area of study as early as their sophomore year. There are also seminar courses and a research symposium that a student can become

involved in before they are officially in the program. Students are also welcome to join in other department events such as the annual picnic and holiday gatherings.

May an MSEG 4+1 BSE/MMSE student continue for a Ph.D.?

Yes, the MSEG 4+1 BSE/MMSE program academic selections are oriented toward a well-rounded preparation for professional life in engineering or continuing their academic career in medical school. Doctoral students must apply for admission to the Ph.D. program by submitting an application for change of field. The appropriate GRE test scores must also be submitted as well as a revised statement of purpose. MSEG 4+1 BSE/MMSE students are admitted only for a Master's degree. Admission to the Ph.D. program is not guaranteed.

CURRICULUM AND GRADUATION

How many undergraduate courses or credits can I count towards the M.S. degree?

You may count six credits toward the M.S. degree. These will usually be courses taken as undergraduate technical electives that are also appropriate for fulfilling the requirements of the MSEG MS degree. Courses that are specifically required for the undergraduate degree are not appropriate for double counting.

When are the concurrent courses taken?

Most students will take the concurrent courses during the last two final terms of undergraduate study. Some may prefer to take one course in one term and the second in the subsequent term.

How do I know which graduate courses to take?

Curriculum listings are available on the MSEG website for each of the concentrations (<http://www.mseg.udel.edu>), or you may pick up a copy from the MSEG office.

Does enrollment in the MSEG 4+1 BSE/MMSE affect when I receive my Bachelor's degree?

You should graduate with your Bachelor of Science degree at the end of the term in which your degree requirements are met. You must complete a diploma application and your final academic audit with your undergraduate department. You must complete the Bachelor's degree within one year of enrolling in the 4+1 BSE/MMSE program. You may participate in the appropriate graduate ceremony for your Bachelor's degree and again when you receive your Master's degree.

What happens after the Bachelor's degree is complete?

Your university standing will be changed to the Master's degree level.

What are the MSEG Degree requirements?

30 credits hours of lecture work are typically required for an MSEG MS degree. However the MSEG 4+1 degree program allows for 6 credits of double counting, so only 24 additional credits are necessary beyond the BS degree. The specific degree requirements are kept current on our web pages (<http://www.mseg.udel.edu>). There are three separate curricula tracks: (1) Soft Materials, (2) Hard Materials, and (3) Composite Materials. Some courses are required for all students, and some are required only for students in a particular track. The specific course requirements are:

(0) MSEG courses required for all students:

Structure and Properties of Materials I
Equilibria in Materials Systems
Structure and Properties of Materials II
Kinetics in Materials Systems

MSEG 608 (Fall)
MSEG 803 (Fall)
MSEG 609 (Spring)
MSEG 804 (Spring)

MSEG Seminar Series

(1) MSEG courses required for Soft Materials students:

Polymer Synthesis	MSEG 632 (Fall)
Polymer Physics	MSEG 635 (Spring)
Polymer Synthesis Lab	MSEG 633 (Spring)

(2) MSEG courses required for Hard Materials students:

Quantum Mechanics	MSEG 640 (Fall)
Solid State Materials I	MSEG 841 (Fall)
Solid State Materials II	MSEG 842 (Spring)

(3) MSEG courses required for Composite Materials students:

Polymer Synthesis	MSEG 632 (Fall)
Composite Materials	MSEG 6YY (Spring)

Other courses in MSEG and other departments can be taken as electives.

Note: the specific course titles and numbers are subject to change, students should always consult with the MSEG department to insure that these are accurate. Some MSEG courses require others as prerequisites, this also needs to be confirmed before registering to avoid delays.

Detailed course descriptions:

MSEG 302 Materials Science for Engineers - 3 credits

Crystal binding and structure; energetics and structure of lattice defects; elasticity, plasticity, and fracture; phase equilibria and transformations; relations of structure and treatment to properties; structures of inorganic and organic polymers; and electronic and magnetic properties.

MSEG 442/642 Semiconductors for Micro- and Nano-Technology - 3 credits (fall)

This course is designed to provide students with an introduction to some of the main themes of the physics of semiconductors, emphasizing the unique properties at the micro- and nanometer scale.

MSEG 601 Structure and Properties of Polymer Materials - 3 credits

Measurement and control of the microstructure and properties of solid polymers. Structure generation, structure-property models and effects

of processing on properties. May be cross-listed with CHEG601.
PREREQ: MSEG302.

MSEG 602 Structure of Materials - 3 credits

Fundamentals of crystallography. Crystal structure analysis by X-ray and electron diffraction. Characterization of materials by optical microscopy, scanning and transmission electron microscopy. Simplified approach to image theory and diffraction theory.

PREREQ: MSEG302.

MSEG 603 Analytical Techniques in Materials Science - 3 credits

Laboratory course in optical microscopy, X-ray diffraction, scanning and transmission electron microscopy, electron diffraction. X-ray fluorescence and microanalysis. Auger analysis and other spectroscopic techniques.

PREREQ: MSEG302 and MSEG602.

COREQ: MSEG602.

MSEG 604 Phase Transformations - 3 credits

Introduction to thermodynamic functions: enthalpy, entropy and free energy. Fick's first and second laws of diffusion. Liquid/solid and solid/solid phase equilibria and transformations. Nucleation and growth. Massive and martensitic transformations. Phase transformations in polymers, ceramics and electronic materials.

PREREQ: MSEG302

MSEG 606 Corrosion and Protection - 3 credits

Degradation of structural materials through interaction with their environment. High temperature oxidation and sulfidation. Electrochemical attack on alloys and its relation to metallurgical structure. Stress corrosion cracking. Testing and control methods. Localized corrosion. Deterioration of advanced materials.

PREREQ: MSEG302.

MSEG 607 Physical Properties of Materials I - 3 credits

Basic models of electrical, magnetic optical and thermal properties of solid materials. Introduction to quantum physics to describe electronic structure of atoms, atomic bonds and crystals. Electronic, magnetic and optical effects in metals, semiconductors, ceramics, polymers and amorphous materials. Operation of basic electronic devices and semiconductor.

PREREQ: MSEG302 and PHYS208.

MSEG 614 Fracture of Materials - 3 credits

Fracture mechanics, micromechanisms, nucleation and propagation of cracks, fracture toughness, ductile-brittle transitions, fatigue, stress, corrosion, irradiation effects and nonmetallic materials. May be cross-listed with MEEG614.

PREREQ: MSEG302.

RESTRICTIONS: Graduate standing acceptable in lieu of Prerequisite.

MSEG 615 Mechanical Properties of Materials - 3 credits

Stress, strain, tensor notation and elementary elasticity. Plasticity and ductility based upon continuum mechanics. Ideal strength of crystalline, polymer and amorphous materials. Real materials: amorphous, polymers, ceramics, metals and composites. Dislocations, strengthening of solids. Mechanisms of fracture, fracture mechanics, fatigue, creep and stress rupture. May be cross-listed with MEEG615.

RESTRICTIONS: Requires graduate status.

MSEG 616 Chemistry and Physics of Surfaces and Interfaces - 3 credits

See CHEG616 for course description.

MSEG 623 Electrical Properties of Matter I - 3 credits

See ELEG623 for course description.

MSEG 667-013- Research Methods and Intellectual Properties

The Objective of this course is to familiarize students with basic US Intellectual Property (IP) principles, as well as how to generate and properly protect IP. Appropriate use of notebook and other documentation during research and development will also be covered. The use of case histories will be used to illustrate basic principles. Text: Alan L. Durham, pPatent Law Essentials, A Concise Guide, Quorum Books, 1999. [ISBN:1-56720-242-X].

MSEG 667-011 - Entrepreneurship and Risk: Meeting the Challenges of a Startup Enterprise - 3 credits

This course is designed to deal with the critical financial, legal, scientific and engineering issues that must be confronted during the initial planning stages of a start-up enterprise. A range of speakers from finance, marketing, engineering, law and the Delaware's Technology Park provide a perspective on the challenges of launching a new business venture. Students from engineering, marketing and finance will work in teams to develop an R&D strategic and a business plan for a new product offering. Lectures will cover the following topics: developing a successful business model, business and professional ethics, safeguarding intellectual property, financial options for

funding a new business, e-Commerce issues, legal proprietorship (LLC, S-corporation, etc.), new product innovation and IP issues.

MSEG 803 Equilibria in Material Systems - credits 3

Classical thermodynamics of condensed systems (macroscopic description). Fundamental laws. Functions and equations of state. Equilibrium and stability criteria. Single component phase equilibrium, multi-component mixtures. Partialmolar properties, non-ideal mixtures. Equilibrium in multi-phase, multi-component systems. Phase Rule.
PREREQ: MSEG302.

MSEG 804 - Kinetics in Material Systems - credits 3

Theory of reaction kinetics. Transport mechanisms in solids. Nucleation and spinodal decomposition. Interfacial attachment and migration. Transition state theory applied to diffusion and phase transformation. Elementary non-equilibrium thermodynamics and phenomenological equations in material transport and phase transformation.

MSEG 807 Physical Properties of Materials II - 3 credits (Spring)

Continuation of MSEG607, with emphasis on the electrical transport properties of materials. Topics include electronic structure and energy band diagrams of semiconductors, metals and insulators; Fermi surfaces; dynamics of electrons; semiconductor materials and devices; band structure and transport properties of selected semiconductors; band-gap engineering; novel materials systems; electron emission; particularly field emission.

MSEG 608 (4 credits)

Structure and Properties of Materials I

Long Description: Introduces general principles of material structure and properties, including chemical and physical bonding, crystal structure, lattices, energy levels, and materials synthesis and chemistry. Introduces the fundamental structure and properties of polymer, solid state and composite materials. Includes a significant laboratory component.

Prerequisites: MSEG302

Justification: The Materials Science and Engineering department is revising its graduate curriculum to reflect broadening research interests, a growing faculty, and the need to balance a broad knowledge of materials science with deep knowledge in student's research areas. This course is part of the revised curriculum and will be required for all new graduate students. The course is intended to begin a comprehensive introduction to materials, emphasizing a common vocabulary for qualitative and quantitative analysis of structure and properties in a wide variety of polymer, organic, inorganic, and composite materials.

Impact: This course will provide a common introduction for all MSEG graduate students and be a prerequisite for advanced material-specific courses.

Change: MSEG 608-609 will replace MSEG 602 and 607, which will be phased out. MSEG 608 will include many topics previously covered in 602, including crystal structure and characterization methods. The new two-semester sequence will include new material on chemical and physical bonding, materials synthesis and chemistry, and introduce the broad classes of materials.

Undergraduate education goals: This course will develop students critical reasoning skills, develop their understanding of scientific search and discovery, and enhance their ability to apply classroom knowledge to real-world materials.

Expected annual enrollment: 20-30 students

MSEG 609 (4 credits)

Structure and Properties of Materials II

Long Description: Introduces mechanical, thermal, electrical, optical, magnetic and biological properties of materials. Considers polymer, solid-state, and composite materials and discusses engineering of material properties via structure, composition, and processing. Includes a significant laboratory component.

Prerequisites: MSEG608

Justification: The Materials Science and Engineering department is revising its graduate curriculum to reflect broadening research interests, a growing faculty, and the need to balance a broad knowledge of materials science with deep knowledge in student's research areas. This course is part of the revised curriculum and will be required for all new graduate students. The course is intended to complete a comprehensive introduction to materials, emphasizing a common vocabulary for qualitative and quantitative analysis of structure and properties in a wide variety of polymer, organic, inorganic, and composite materials.

Impact: This course will provide a common introduction for all MSEG graduate students and be a prerequisite for advanced material-specific courses.

Change: MSEG 608-609 will replace MSEG 602 and 607, which will be phased out. Many topics covered in 607, including the electric, thermal, optical and magnetic properties of materials, will be covered in the new courses. The new two-semester sequence will include a unified introduction to material properties in a variety of different materials.

Undergraduate education goals: This course will develop students critical reasoning skills, develop their understanding of scientific search and discovery, and enhance their ability to apply classroom knowledge to real-world materials.

Expected annual enrollment: 20-30 students

MSEG 640 (3 credits)

Applied Quantum Mechanics

Long Description: Quantum mechanics for scientists and engineers working with electronic materials. Introduce fundamentals: Schroedinger's equation, eigenfunctions and eigenvalues, operators, Dirac notation, tunneling, harmonic oscillators, perturbation theory and approximation methods. Focus on practical applications in devices and developing techniques that can be applied to research problems.

Prerequisite: MSEG608 to be taken as prerequisite or corequisite.

Justification: The Materials Science and Engineering department is revising its graduate curriculum to reflect broadening research interests, a growing faculty, and the need to balance a broad knowledge of materials science with deep knowledge in student's research areas. This course is part of the revised curriculum and will be required for all new graduate students studying solid-state materials. The course is intended to provide the quantum mechanics background necessary for an in-depth study of solid-state materials.

Impact: This course will introduce quantum mechanics at a graduate level and permit MSEG 841-842 to be taught at an appropriate level for graduate students who will work on solid-state materials.

Change: Quantum mechanics is required for in-depth instruction in solid-state materials, but is presently covered only briefly as part of a course covering a broad range of topics (MSEG 607). The creation of this new course will provide a solid and comprehensive foundation in quantum mechanics and allow solid-state materials to be taught at an appropriate level.

Undergraduate education goals: This course will develop students critical reasoning skills, develop their understanding of scientific search and discovery, and enhance their ability to apply classroom knowledge to real-world materials.

Expected annual enrollment: 10-15 students

MSEG 841 (3 credits)

Solid State Materials I

Long Description: Structure and properties of solid-state materials, including inorganic atomic structure and lattices, calculation of three-dimensional energy bands and band gaps, calculation of density of states, derivation of physical properties from the density of states, electronic properties of materials, models for approximating band structure and phonons.

Prerequisites: MSEG609, MSEG640

Justification: The Materials Science and Engineering department is revising its graduate curriculum to reflect broadening research interests, a growing faculty, and the need to balance a broad knowledge of materials science with deep knowledge in student's research areas. This course is part of the revised curriculum and will be required for all new graduate students studying solid-state materials. The course will provide a graduate-level introduction to solid-state materials appropriate for students pursuing research in this field.

Impact: This course will provide a comprehensive introduction to solid-state materials. Several proposed new courses will be prerequisites.

Change: MSEG 841-842 will replace MSEG 607-807, which are being phased out. Topics applicable to all classes of materials, such as thermal, electrical, and optical properties, that were previously included in MSEG 607 will now be covered in MSEG 608-609. MSEG 841-842 will focus exclusively on solid-state materials, thus permitting a more rigorous introduction to the field for students who will pursue research in this area.

Undergraduate education goals: This is a graduate course, which will develop rigorous scientific analysis skills with application to real-world materials.

Expected annual enrollment: 10-15 students

MSEG 842 (3 credits)

Solid State Materials II

Long Description: Properties of solid-state materials, including magnetic properties, optical properties, electrical properties, scattering and tunneling transport. Introduction to semiconductor devices and low-dimensional structures.

Prerequisites: MSEG841

Justification: The Materials Science and Engineering department is revising its graduate curriculum to reflect broadening research interests, a growing faculty, and the need to balance a broad knowledge of materials science with deep knowledge in student's research areas. This course is part of the revised curriculum and will be required for all new graduate students studying solid-state materials. The course will provide a graduate-level introduction to solid-state materials appropriate for students pursuing research in this field.

Impact: This course will provide a comprehensive introduction to solid-state materials. Several proposed new courses will be prerequisites.

Change: MSEG 841-842 will replace MSEG 607-807, which are being phased out. Topics applicable to all classes of materials, such as thermal, electrical, and optical properties, that were previously included in MSEG 607 will now be covered in MSEG 608-609. MSEG 841-842 will focus exclusively on solid-state materials, thus permitting a more rigorous introduction to the field for students who will pursue research in this area.

Undergraduate education goals: This is a graduate course, which will develop rigorous scientific analysis skills with application to real-world materials.

Expected annual enrollment: 10-15 students

From: "Shenton, Tripp" <shenton@admin.udel.edu>
Subject: **RE: MSEG 4+1 BS/MS Degrees**
Date: November 5, 2009 3:50:58 PM EST
To: "Martin, David C." <milty@admin.udel.edu>
Cc: "Shenton, Tripp" <shenton@admin.udel.edu>

Dave...

On behalf of the faculty in the Department of Civil and Environmental Engineering I would like to say we support the idea of the 4+1 BS/MSEG program that your department is proposing. It sounds like a great opportunity and should be of interest to some civil or environmental majors.

Sincerely

Tripp

Harry W. "Tripp" Shenton III, Ph.D.
Professor and Chair
Department of Civil and Env. Engineering
301 -B Dupont Hall
University of Delaware
Newark, Delaware 19716
(302)831-2447
(302)831-3640 Fax
Email: shenton@udel.edu

-----Original Message-----

From: Martin, David C.
Sent: Thursday, November 05, 2009 2:40 PM
To: rlduncan@udel.edu; theopold@udel.edu; Norbert Mulders; Wagner, Norman J.; Kenneth Barner; Karlsson, Anette M.; Shenton, Tripp
Subject: MSEG 4+1 BS/MS Degrees

I have spoken with each of you recently about our interest in initiating 4+1 BS/MS degrees in Materials Science and Engineering here at Delaware. We are hoping to provide an opportunity to continue on in graduate school for undergraduates in the other engineering departments (Chemical, Civil and Environmental, Electrical and Computer, and Mechanical), as well as for students in Arts & Sciences (primarily Chemistry, Physics, and Biology, although perhaps the might be others as well). I'm enclosing an updated version of our plan, including some corrected information about class numbers and some other minor clarifications from the previous edition. What I would like to request if possible is a short support statement from each of you that I could include in the final approval package. While our degree doesn't change any of the requirements for the undergraduate degree, it will certainly be necessary for each of the partnering undergraduate programs to agree to double count up to six MSEG graduate level courses for undergraduate elective credit. Even though this degree is not yet official I've already started to receive inquiries from interested students, and we are hoping to get it initialized by fall 2010.

So if you are willing to work with us on this I'd appreciate just a short note to that effect (e-mail should be fine). Also, I'd appreciate in advance if you could help us spread the word to any interested students once the program is officially in place. Let me know if any questions.

From: "Barner, Kenneth E." <barner@admin.udel.edu>
Subject: **RE: MSEG 4+1 BS/MS Degrees**
Date: November 12, 2009 1:51:52 PM EST
To: "Martin, David C." <milty@admin.udel.edu>

David:

I apologize for the delay. But I am certainly supportive of your 4+1 program. I understand the issue raised previously regarding the language utilized in the double counting of credits. So if that is clarified for the students, I don't see any problem. Thus I am supportive of the program and will help get the word out.

Ken

-----Original Message-----

From: Martin, David C. [mailto:milty@UDel.Edu]
Sent: Thursday, November 05, 2009 2:40 PM
To: rlduncan@udel.edu; theopold@udel.edu; Norbert Mulders; Wagner, Norman J.; Kenneth Barner; Karlsson, Anette M.; Shenton, Tripp
Subject: MSEG 4+1 BS/MS Degrees

I have spoken with each of you recently about our interest in initiating 4+1 BS/MS degrees in Materials Science and Engineering here at Delaware. We are hoping to provide an opportunity to continue on in graduate school for undergraduates in the other engineering departments (Chemical, Civil and Environmental, Electrical and Computer, and Mechanical), as well as for students in Arts & Sciences (primarily Chemistry, Physics, and Biology, although perhaps the might be others as well). I'm enclosing an updated version of our plan, including some corrected information about class numbers and some other minor clarifications from the previous edition. What I would like to request if possible is a short support statement from each of you that I could include in the final approval package. While our degree doesn't change any of the requirements for the undergraduate degree, it will certainly be necessary for each of the partnering undergraduate programs to agree to double count up to six MSEG graduate level courses for undergraduate elective credit. Even though this degree is not yet official I've already started to receive inquiries from interested students, and we are hoping to get it initialized by fall 2010.

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From: "Karlsson, Anette M." <karlsson@udel.edu>
Subject: **RE: MSEG 4+1 Degrees at Delaware**
Date: October 28, 2009 2:23:36 PM EDT
To: David Martin <milty@umich.edu>
▶ 1 Attachment, 126 KB

Dave,

Just a few comments on your proposal:

You need to say explicitly that there are no changes to any of the requirements for the current engineering undergraduate programs. Would you also accept students from other u/g programs, such as Chemistry or Biology at UD?

Do you have a "coursework only Masters degree" already? If not, you need to create that degree as well. If you have one (we do), then you need to say that there are no changes in the requirements in that degree either.

So, with no changes in u/g or coursework-only MS, the only change you are really suggesting is allowing the 6 credit "double-dipping" which I think is what all the other department do.

Also, the format of the write-up to the educational committee needs to be adopted to the UD senate required format.

I suggest you contact Mike Keefe directly since he knows all these administrative things that needs to be handled. keefe@udel.edu I attached our proposed plan which may or may not be helpful.

I hope this helps,

Anette

-----Original Message-----

From: David Martin [mailto:milty@umich.edu]
Sent: Tuesday, October 27, 2009 4:42 PM
To: Wagner, Norman J.; Kenneth Barner; Shenton, Tripp; Karlsson, Anette M..
Subject: MSEG 4+1 Degrees at Delaware

Norm, Ken, Tripp, and Anette:

As you know we in MSEG are interested in establishing 4+1 BS/MS degrees, and I'm hoping that it will be possible to encourage students from each of your individual departments to become interested in pursuing this option. My guess is that most of the interest will come from the ChE and ME students, but there may also be a number of folks interested in this option from ECE, and from Civil and Environmental as well. I helped to initiate similar programs while I was at Michigan, and found that they also helped to encourage students on the borderline more seriously consider continuing on for a PhD. I've enclosed for your information a document that we have put together to help explain things to interested parties, and appreciate in advance any comments you might have.



[4+1.pdf \(126 KB\)](#)

From: Norbert Mulders <mulders@UDel.Edu>
Subject: **Re: MSEG 4+1 BS/MS Degrees**
Date: November 8, 2009 3:24:38 PM EST
To: "Martin, David C." <milty@admin.udel.edu>
Cc: "riduncan@udel.edu" <riduncan@UDel.Edu>, "theopold@udel.edu" <theopold@UDel.Edu>, "Wagner, Norman J." <wagnernj@admin.udel.edu>, Kenneth Barner <barner@ece.udel.edu>, "Karlsson, Anette M." <karlsson@admin.udel.edu>, "Shenton, Tripp" <shenton@admin.udel.edu>, "hadji@UDel.Edu" <hadji@UDel.Edu>, Edmund Nowak <nowak@UDel.Edu>

David,

This is new to me:

"it will certainly be necessary for each of the partnering undergraduate programs to agree to double count up to six MSEG graduate level courses for undergraduate elective credit."

Apparently not a mistake as it now states in the document that you sent me:

4+1 BS/MMSE PROGRAM

Students admitted to the 4+1 BS/MMSE program must meet all the above requirements for the MMSE degree. However, these students are required to complete two of the required courses during enrollment in the BS degree. These two courses can also be counted toward meeting the technical elective requirements of the respective BS degree.

We have no problem with our majors taking MSEG courses, but we do not see those as substitution for PHYS or MATH courses required for a Physics/astronomy degree. Students always have the option to take courses in the category " other credits". Those can be MSEG courses if that fits their needs, that is up to them. As far as physics is concerned, to avoid confusion as to what "technical elective requirements" might mean, it would be better to phrase the last sentence as

These two courses can also be counted toward meeting total course credits requirements of the respective BS degree.

although this is in fact redundant. The point is not that courses that are used for the MSEG masters can be used for BS, but rather that the University allows that courses that are already used to meet BS requirements are then re-used for an MS degree.

Norbert

Martin, David C. wrote:

I have spoken with each of you recently about our interest in initiating 4+1 BS/MS degrees in Materials Science and Engineering here at Delaware. We are hoping to provide an opportunity to continue on in graduate school for undergraduates in the other engineering departments (Chemical, Civil and Environmental, Electrical and Computer, and Mechanical), as well as for students in Arts & Sciences (primarily Chemistry, Physics, and Biology, although perhaps there might be others as well). I'm enclosing an updated version of our plan, including some corrected information about class numbers and some other minor clarifications from the previous edition. What I would like to request if possible is a short support statement from each of you that I could include in the final approval package. While our degree doesn't change any of the requirements for the undergraduate degree, it will certainly be necessary for each of the partnering undergraduate programs to agree to double count up to six MSEG

graduate level courses for undergraduate elective credit. Even though this degree is not yet official I've already started to receive inquiries from interested students, and we are hoping to get it initialized by fall 2010.

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--

Norbert Mulders
Director, Physics and Astronomy Undergraduate Programs
Department of Physics and Astronomy
University of Delaware