

INFORMATION FOR GRADUATE STUDENTS

Welcome to the Materials Science and Engineering Department. Please refer to this booklet throughout your years as a graduate student. Every effort has been made to anticipate your questions, on adviser selection through final check-out. You are responsible for knowing this material!

I. TEMPORARY ADVISERS

During New Student Week, you will be assigned a temporary adviser who will assist you in selecting courses for your first quarter of study, and you will have time to meet with him/her before online course registration for new students is available on Monday, September 23rd. Students with research assistantships (RA's) are to register for three courses plus one unit of 590 Research (formerly known as E90). Those students with fellowships or their own support may register for four academic courses.

Domestic PhD students entering with BS degrees only and who begin classes with Fall Quarter (this includes students who begin their graduate programs with Summer Quarter) have the option of delaying their choice of programs (MS/PhD, PhD) until the end of Spring Quarter, regardless of what was indicated on their application forms. All other students must declare their immediate degree objective (MS, PhD) at the time of arrival. The temporary adviser will also assist in the selection of degree objective. The various programs are outlined in sections below. Note: To be eligible for university fellowships, students must be in either PhD or MS/PhD programs.

II. PERMANENT ADVISERS

A. The Selection Process

Students arriving for the Fall Quarter are given the opportunity to meet all our faculty members prior to selecting an adviser. Most of the faculty will opt for group presentations of their research, usually during New Student Week. Others may choose to meet with students individually. Faculty members giving group presentations will encourage interested students to contact them for follow-up meetings. Such meetings are extremely important as they aid the faculty in evaluating the qualifications of a given student. Individual sessions may be used to discuss specific research projects and availability of funding, but no formal or informal agreement as to adviser selection is to be made at this time. A form will be provided requiring the signatures of every faculty member to be submitted with the adviser choice form.

On or before October 9th, 2002, each student must submit a form to Joanna Gwinn containing the student's first, second, and third choices of research adviser and research topic. Three choices must be indicated, though it is permitted to include two (but not three) research projects of one faculty member. In this case, a fourth choice (third possible adviser) must be indicated. These lists will be collated, reviewed, and acted upon at a meeting of the faculty. Students' preferences for permanent adviser and research topic will be honored to the extent possible. Any student who can be accommodated only by his or her third choice will be consulted by the Department Chair before all final assignments of permanent advisers are made.

Students entering in the Winter, Spring or Summer Quarter will work with the recruiting chair and the department chair to select an adviser. The student is, however, encouraged to discuss research interests with every faculty member in residence.

Part-time students may take up to a full quarter to select a permanent adviser.

It is hoped that these processes will provide each student with an adviser who will satisfy the student's research interests. Faculty members in the Department conduct research over a wide spectrum of areas. Please be aware, however, that availability of any particular project is governed by the presence of funds to support that research.

In rare instances, a change of adviser may be necessary due to loss of funding or for other reasons. Such changes are handled by the Department Chair on an individual basis.

B. The Faculty Adviser's Role and the Student's Study Plan

The permanent adviser is available to provide advice concerning your graduate studies and should be consulted about course selection. The adviser may, especially in the early stages of your graduate career, provide fairly close direction of your thesis research. The adviser will also serve as chairman of the faculty committee that conducts your qualifying examination and your thesis defense.

Before registration for winter quarter begins (mid-November) a complete program of study should be planned, approved by the adviser, and submitted to Joanna Gwinn for approval by the Associate Chair. A Study Plan form is provided in the Appendix. Any subsequent changes in this program must have the approval of the adviser and the plan must be updated in the student's file. *Responsibility for meeting published deadlines and degree requirements rests with the student.*

III. MS DEGREE REQUIREMENTS

A. MS with thesis

Class Work: The minimum requirement for a Master's degree is the equivalent of three quarters of full-time study (consisting of three or four units each quarter). Candidates for the standard Master of Science degree must complete a minimum of six quarter courses plus three units of 590 Research. At least four of the courses must be advanced classes (listed in the *Graduate School Bulletin*) in Materials Science and Engineering, including 401 (Chemical Thermodynamics of Materials) and at least two other Mat Sci 400-level courses. A student entering this program with a BS degree in the field of materials science and engineering, or materials engineering, must take at least one advanced course outside the department in other fields of engineering, mathematics, or science. **Classes must be taken for a grade rather than pass/fail.** As soon as the program of study has been determined, a Study Plan (included in the Appendix) should be submitted to Joanna Gwinn.

After completing six units of graduate credit (with an NU grade average of B or better) and the three units of 590, the student should apply for admission to candidacy. The Graduate School's Application for Admission to Candidacy form is available in the Department Office and should be completed by the student, signed by the adviser, and given to Sharon Jacknow. (Check the time-table in the front of the *Graduate School Bulletin* for exact dates this paperwork is due in the Graduate School, since it changes yearly. Generally, it is late September for a December degree and early April for a June degree.)

Note: At the end of the first three quarters of study, an MS student may petition to forego the MS degree and become a candidate for the PhD. This is accomplished by submitting a study plan along with a petition (both approved by the adviser) to the Department Chair. This petition will be considered by the faculty during a regularly scheduled Preliminary Evaluation. If approved, the student will follow the instructions for "PhD Students entering with an MS Degree" below. If denied, the student is still eligible for an MS

degree. At the MS Final Examination (see section III.B) the committee will recommend whether the student is eligible to continue for the PhD. If deemed eligible, the student should follow the instructions for "PhD Students Entering with an MS Degree" below.

Thesis Defense: Full-time students must write a thesis on their research work and defend it at an oral examination within six quarters (counting summer) after they are enrolled in the MS program. No registration will be permitted after this 18-month period until the thesis is completed, except that the student may register for an additional quarter of 588, Resident Master's study, with the approval of the Graduate School.

The Department also has an option whereby, in lieu of a thesis, an MS student may submit a paper published (or a manuscript refereed and accepted for publication) in a scientific or technical journal that is based upon research carried out while a grad student in the department. The paper must be approved by the faculty adviser and defended in an oral examination. The MS student should be first author on the paper. If not, a letter from the adviser is required specifying the contribution of the student to the research described. A copy of the paper should be provided for the student's file.

In either case, the examination committee will be composed of the student's faculty adviser plus at least two other faculty members, one of whom may be from another department in the University. The committee is approved by the adviser and appointed by the Department Chair. The student may elect to present a public summary of the research, which is then followed by a private examination by the committee.

Procedure: Sharon Jacknow must be notified of the names of the committee members and the date and time the exam is to be taken **at least 3 weeks** before the exam. The student obtains an Application for Defense form from Sharon and reserves a suitable conference room. Each member of the committee must be furnished with a copy of the thesis **at least ten days** before the exam, so that the committee will have time to review it. Generally, MS thesis formatting follows the Graduate School's booklet on "Preparation and Submission of the Dissertation," with the additional option for references noted in section III.J.

The student should also check the MS requirements and calendar in the *Graduate School Bulletin* for any NU regulations and deadlines. For a June or December degree, the exam must be taken and all papers filed with the Graduate School approximately one month in advance.

One copy of the approved thesis must be turned in to the Materials Science and Engineering Department office to be bound for the Department library. A second copy should be submitted to the Science and Engineering Library to be bound for their collection. There is no charge for binding these two copies. A student may give the secretary additional copies to be bound at personal expense. Payment should be in cash if the student is leaving the area after completion.

If leaving NU after the MS degree, the student should follow the departmental checkout procedure – see Sharon Jacknow.

B. Courses-Only MS Option

A Courses-Only MS requires a total of twelve courses without the thesis requirement. Eight of the twelve must be advanced MSE courses (listed in the *Graduate School Bulletin*) including 401 and four additional 400 levels. **Classes must be taken for a grade rather than pass/fail.**

Students in this program are not eligible for financial support from the department. **Current students cannot transfer to the Courses-Only MS after financial support has been accepted.**

After completing nine units of graduate credit with a grade of B or better, the student should apply for admission to candidacy. (See section A above and the *Graduate Bulletin*.)

C. Part-time Students

Part-time students may study for the MS degree in Materials Science and Engineering. Responsibility lies with the student to be aware of modified residency requirements and other conditions described in the *Graduate School Bulletin*. Part-time students may not receive financial aid from the Department. Requirements for the MS degree are modified as follows. 1) The 18-month time requirement does not apply. 2) Research may be presented in a thesis, a refereed paper accepted for publication, or a detailed technical report. Research presented for the degree must have been performed after the student entered the Department for MS study.

IV. PhD DEGREE IN MATERIALS SCIENCE AND ENGINEERING

A. Residency and Course Load

The minimum requirement for the PhD degree is three years of advanced study, two of which must be at Northwestern. At least one academic year (three consecutive quarters) must be spent in full-time study. Students who hold research assistantships may take no more than three courses per quarter plus one unit of 590 Research. Those with fellowships may take up to four courses and no 590 registration if they wish to do so.

Part-time students may study for the PhD in Materials Science and Engineering. Responsibility lies with the student to be aware of modified residency requirements and other conditions described in the *Graduate School Bulletin*. Part-time students may not receive financial aid from the Department. A study plan, approved by the adviser, must be submitted to the Associate Chair prior to any academic work. Full-time students spend nearly two full years on course work followed by one, two, or more years of full-time research. Part-time students should therefore anticipate a lengthy program with substantial release-time from their employers in order to fulfill a part-time PhD. A leave-of-absence is often required to complete the thesis.

B. Research

Graduate study should be considered full-time employment. Students are expected to be fully involved in laboratory research under the supervision of their advisers, with a minimum 20-hour week requirement even during coursework. After coursework is completed, a minimum of 40 hours per week is expected. Student research during the first year is evaluated by the faculty at the Preliminary Evaluation.

C. Course Requirements

1. Students Entering with BS Degree

Students entering with a BS Degree must take at least fifteen-quarter courses. **P/N grades are not allowed. Full-time students are required to take at least nine academic courses during their first three quarters (excluding the summer quarter) of graduate study at Northwestern.** Enrollment in the core curriculum is mandatory. Petitions for exceptions due to course conflicts, etc., must be signed by the adviser and approved by the associate chair. In addition to the core courses, four additional 400 level MSE courses (excluding 499) are required. According to University policy, students must maintain a 3.00

average to receive financial assistance.

a. Core Courses in Materials Science and Engineering: The following five courses comprise the graduate core curriculum in materials science and engineering and are to be taken in sequence by all students in their first four quarters (excluding summer) of graduate study.

Fall Quarter (1st Year)

401 Analytical and Statistical Thermodynamics of Materials

405 Physics of Solids

Winter Quarter (1st Year)

404 Imperfections in Materials

408 Phase Transformations in Materials

Spring Quarter (1st Year)

406 Symmetry and Mechanical Properties of Materials

Students entering in Winter Quarter should consult with their advisers concerning core course registration.

Fractional grading (A+ = 4.33, A = 4, A- = 3.67, B+ = 3.33, B = 3, B- = 2.67, C+ = 2.33, C = 2, C- = 1.67, and F = 0) will be used in these courses for internal departmental use only. (Official graduate school grades for these courses will not be fractional, i.e. A, B, C, etc.)

Preparing for the Core Courses:

Temporary advisers and core-course instructors will assist students in determining their academic readiness for the graduate core program. To insure adequate preparation, students may, with the permission of the adviser and Associate Chairman, include up to two courses in the fifteen course requirement from the following list of classes normally not open to MSE graduate students. The course must aid preparation for core courses and must not correspond to any courses taken previously. MSE 351-1 or Physics 339-1 are recommended for students with insufficient background in elementary quantum mechanics to prepare for 405; MSE 332 is recommended for students with insufficient background in mechanical behavior for 406. Because of the math content of the core courses, Applied Math 311-1 and 2 may be useful for some students.

Classes normally not open to MSE graduate students:

315 Phase Equilibria and Diffusion in Materials

316-1, 2 Microstructural Dynamics

317 Materials in Manufacturing

332 Mechanical Behavior of Solids

351-1, 2 Introductory Physics of Materials

360 Electron Microscopy

Waiving Core Courses:

Students who are sufficiently prepared in the subject matter of a core course may submit a waiver form (included in the Appendix) signed by the instructor of the course and approved by the adviser and Associate Chairman. The instructors may require documentation, e.g. text used, course outline, lecture notes, exams, etc. The signed form should be given to Joanna Gwinn to be placed in the student's file. Please note that the waiving of a course does not decrease the total number of courses required.

b. Minor Field of Study: PhD students are required to increase the breadth of their knowledge by taking at least two advanced courses *outside of the area of their research specialty*. These two courses should be closely related to each other so as to constitute an identifiable minor field of study. They may be from within the Department provided they are 400-levels, or outside the Department if in engineering, mathematics or the physical sciences, and if listed in the *Graduate School Bulletin* (300-levels permitted). Students are encouraged to get an early start on taking their minor courses.

The courses for the minor field of study must be declared on the Study Plan, approved by the adviser, and submitted to the Associate Chair prior to the Preliminary Evaluation (see section IV.A.).

The remaining of the 15 courses for the PhD are to be selected by the student in consultation with his or her adviser and must be specified on the Study Plan. These can be in the Department or in engineering, mathematics or the physical sciences provided they are listed in the *Graduate School Bulletin* and are not among the 300-level courses listed above (see section IV.B.1.). Any courses taken for the PhD must be an extension of the student's background rather than a repetition of work done as an undergraduate.

A student may apply one unit of 499 (Projects) toward the 15-course requirement.

International students may take Linguistics 380, Spoken English for Non-Native Speakers and Linguistics 381, Written English for Non-Native Speakers in place of units of 590. These courses, however, do not count toward the 15 courses required for the PhD and may be taken P/N.

c. Other courses of possible interest:

Industrial Engineering (IEMS) 410, Introduction to Technology Management:

Basic issues in technology management and problem solving in high-tech organizations. Methods for identifying or solving problems, including use of case studies and field research.

IEMS 419, Technical Entrepreneurship Inside and Outside the Company:

Research and development projects and ventures. Circumstances requiring special treatment, alternative organizational forms for venture/entrepreneurial projects, kinds of people required, financial considerations, impact on career paths, and organizational relations.

2. MS/PhD Program

Although the University offers an MS/PhD option, the Department does not encourage this choice except in special circumstances. We recommend that any student in the MS/PhD program enroll in as much of the standard graduate core curriculum as possible while completing the MS thesis in order not to delay

completion of the PhD degree. (Students in this program may decide to forego the MS entirely by submitting an approved PhD Study Plan and a research report before the regularly scheduled Preliminary Evaluation in June.)

3. Students Entering with MS Degree

The Graduate School will grant up to three quarters of residency based on the MS transcript. The office must receive a copy of this letter for your permanent file. A maximum of eight quarter courses taken during study for an MS degree may be counted toward the 15 quarter course requirement if a grade of "B" or better was obtained in each course. All other requirements, i.e. five core courses and four additional 400-level courses (section IV.B.1.), and minor field (section IV.B.2.) must still be satisfied. Transferred courses (included in the eight) can be used for these. Transferred courses should be listed on the study plan *with the grade received*. P/N grades are not allowed for NU coursework. A 3.00 average must be maintained to receive financial assistance.

In the event that an entering student has been enrolled in, but not completed, a degree-granting MS program, a maximum of eight courses satisfactorily completed with a grade of "B" or better while in that program may, with Graduate School approval, be counted toward the PhD requirements. Again, all other requirements, i.e. core, 400-level, and minor course requirements, must still be fulfilled; transferred courses can be used for these.

Permission to count courses taken during MS study against the five core courses may be granted by the individual instructors of those courses and approved by the adviser and Associate Chair. The instructors may require documentation, e.g. text used, course outline, lecture notes, exams, etc. A waiver form for this process is in the Appendix. If an exemption is granted, the signed form should be returned to Joanna Gwinn to be placed in the student's file. If the exemption is not granted, the student may still opt to take a representative final exam for the course. A grade of B or better is necessary to receive transfer credit for the course. Please note that waived courses do not decrease the total number of courses required.

D. Teaching Assistant (TA) Requirement

The Department assigns graduate students to assist in MSE classes with large enrollments or laboratory requirements. Assignments vary in the number of hours per week (4 to 5 or 8 to 10) and in tasks required (grading, office hours, assisting in lectures, etc.) Each doctoral student is required to serve as a teaching assistant at least twice during his/her graduate program for a total of 12 to 15 hours (one 8-10 hr/wk assignment and one 4-5 hr/wk assignment or three 4-5 hr/wk assignments) It is recommended that students request assignments early in their program to avoid being assigned at a less opportune time. As a rule, however, international students are not eligible during their first year. Prospective TA's are encouraged to attend the training sessions offered by the university. (See <http://www.nwu.edu/graduate/TAHandbook/>).

The TA experience is an excellent opportunity to enhance communication skills. Students are encouraged to serve more than the required minimum. TA's will be compensated at \$200/mo. for an 8-10 hr./wk. and \$100/mo. for a 4-5 hr./wk. assignment. Each quarter Sharon Jacknow will circulate a list of courses requiring TA's. Actual assignments are made by the Associate Chair. Students will not necessarily assist in courses taught by their adviser. Some full-time teaching assistantships are also available. The University stipend is brought to the departmental RA level by the adviser, with the department adding the TA supplement.

E. The Preliminary Evaluation

1. PhD Students Entering with BS Degree: After completing nine course credits and the required core courses, students wishing to continue toward the PhD must undergo a Preliminary Evaluation by the entire faculty. The basis for the Preliminary Evaluation will be performance in research, core course performance, overall grade point average, and adviser comments. Other factors such as the student's undergraduate major and work ethic may also be considered.

An accurate study plan must be on file.

The Research Report: Performance in research is evaluated through the student's provision of a research report, submitted to Joanna Gwinn on the last day of classes of the 3rd quarter of course work. The report is a one-page write-up of research progress (not a literature review) to date. It should include a concise statement of research topic, objectives, approach, and summary of progress. The report must be prepared in no finer than 12-pt. font size.

Three possible outcomes will result from the preliminary evaluation:

a. **Satisfactory Progress:** The student may proceed with coursework and begin to prepare for the Qualifying Examination.

b. **Questionable Progress:** The student will be re-evaluated after a time period specified by the faculty. Students being re-evaluated after an additional specified time period will be notified whether their progress is "satisfactory" or "unsatisfactory".

c. **Unsatisfactory Progress:** The student is not eligible for the PhD program but can still complete an MS degree. In a rare instance, a student who previously failed the Preliminary Evaluation may so distinguish himself or herself at the MS Final Examination that the committee may recommend that he or she continue for the PhD. This issue will be decided by the faculty. If approved, the student must submit a revised PhD Study Plan to the Associate Chair and may proceed with coursework and begin to prepare for the Qualifying Examination.

2. PhD Students Entering with an MS Degree: Full-time students are required to take at least six academic courses, for letter grades, during the first two quarters (excluding summer) of graduate study as a PhD student. Any core courses being offered for which the student does not have transfer credit must also be taken. A signed study plan should be submitted before registration for the second quarter of study. Before their third academic quarter, these students must undergo a Preliminary Evaluation. (Submit the research report before second quarter exams, as indicated above.) In the event that the student is deemed to be making "questionable progress", he or she will be re-evaluated after a time period specified by the faculty. At this time the decision will be "satisfactory" or "unsatisfactory", with the outcomes as spelled out above.

3. MS/PhD Students: At the MS Final Examination (see section III.B) the committee will recommend whether a student is eligible to continue for the PhD. If eligible, the procedure for the Preliminary Evaluation is the same as for "PhD Students Entering with an MS Degree" above. Alternatively, MS/PhD students who have followed the PhD course load may opt to forego the MS degree, with the permission of the adviser, anytime before the preliminary evaluation for their entering class.

4. Part-time PhD Students: Part-time students are required to complete all core courses prior to undertaking any other coursework. They will undergo the Preliminary Evaluation outlined above upon completion of the five core courses if entering with a BS, or three if entering with an MS. If their progress is deemed "questionable", they will be re-evaluated after a time period specified by the faculty.

F. The Qualifying Examination

1. Time Requirements: **Students entering with a BS degree** must take the Qualifying Examination before the sixth week of their ninth quarter (including summers). Students are encouraged to take the examination earlier, if possible. **Those entering with an MS degree** must take the Qualifying Examination before the end of their fifth quarter (including summer).

Part-time students must take the Qualifying Examination within one quarter after completing coursework.

Students failing to pass the Qualifying Examination within these time limits cannot continue to receive financial aid from University sources (Research Assistantships, Fellowships, and Teaching Assistantships). Aid may be restored when the student has successfully passed the Qualifying Examination. The Qualifying Examination Committee has the right to pass a student with the requirement that certain additional conditions (such as English proficiency--see below) be satisfied within specified time limits.

A student is not recognized by the Graduate School as a candidate for the PhD degree until the Qualifying Examination is passed.

2. Qualifying Examination Procedure and Committee Makeup: The examination will be wholly or partially oral and may cover courses taken both in and out of the Department, though emphasis is normally on the student's specialty in Materials Science and Engineering and the proposed thesis research. The exam will be conducted by a committee consisting of three or more regular faculty members of this Department and at least one faculty member from another department, or a suitable expert in the field of the candidate's thesis from outside the University. The department requires that all committee members must hold doctoral degrees. Faculty members with joint appointments in the Department are considered internal members of a committee; those with courtesy appointments are considered external members.

Students should:

a) Personally contact each member of the committee asking if each is willing to serve and to find a date and hour satisfactory to each one. Reserve a conference room for at least 2 hours.

b) Obtain their Study Plan from Joanna Gwinn and a Request for Qualifier form from Sharon Jacknow (or the Appendix of this booklet). Update and have the adviser initial any changes on the Study Plan.

c) Return the form and Study Plan to Sharon Jacknow **three weeks** before the qualifying exam is to be held. The Associate Chair will review the Study Plan and the student and adviser will be notified whether or not the student's status is appropriate for the taking of this exam. If everything is in order, the Department will then recommend the examination committee to the Dean of the Graduate School.

d) Furnish each member of the committee with a copy of the proposed thesis research **at least seven days** prior to the examination. A good proposal should be concise and convey all of the following in not more than 20 pages: (1) The objectives of the research--what is to be accomplished. (2) The

significance of the research--what impact the accomplished objectives would have, assuming the research progresses as planned. (3) The literature background--enough description of prior knowledge for readers to understand what is deficient that makes the proposed work important and useful, and what is known so that the proposed work has a reasonable chance of success. (4) A logical plan of attack—a description of foreseen difficulties, options, and plans to overcome the difficulties. (5) A brief description of the procedure, which could be theoretical, analytical, computational, or experimental. (6) A brief description of work completed by the student.

3. English Language Requirement: Those students whose first language is not English are advised to take every opportunity to converse with others in English. The Linguistics Department offers Spoken English for Non-native Speakers (LING-380) described in the *Graduate Bulletin*. For those who wish smaller conversation groups, tutors are available through the Community Council for International Students (CCIS). Also there are a number of Americans who wish to improve their knowledge of another language and are willing to exchange English conversation with (for example) Spanish conversation. For more information on these classes, call the current CCIS Chairman, whose phone number is available from the International Office (1-5613).

The committee for the PhD Qualifying Examination will judge the candidate's ability to understand and convey ideas in the English language. Committee members will recommend needed courses or tutoring in this area and the Qualifying Examination will not be considered complete by the department until this requirement (as well as the others) is fulfilled *to the committee's satisfaction*. If the student passes the technical portions of the examination, but not the language portion, the student will be certified as having passed only the minimum requirements of The Graduate School, thus allowing registration for Post-Candidacy Research. However, the student will be responsible for all tuition costs until the English language requirement is satisfied, in view of the research time lost in continued study of English.

G. The Crown Family Graduate Internship

PhD candidates may choose to participate in the Crown Family Graduate Internship Program, usually in the later stages (e.g., the third year) of PhD study, gaining practical experience in industry or national research laboratories in areas related to research interests. An internship can significantly boost the thesis effort and may provide a basis for future employment.

A proper position is found with the help of the student's thesis adviser, the associate dean for graduate studies and research, and the director of industrial relations. The student works full time for three, six or nine months and generally is paid by the participating sponsor. In the rare instance where an internship is taken earlier in the student's program, a Crown Internship opportunity may postpone the Qualifying Exam.

H. Post-Qualifier Reviews

At the discretion of the adviser or at the request of the student, a research review may be conducted eighteen months after the Qualifying Examination. The intent of the review is to ensure that (i) the research is on track, and (ii) the student and the advisor are both aware of what remains to be done to complete the thesis. The review involves the same committee as the Qualifying Examination. However, the external member, if from out of town, can perform the review by mail. The student is responsible for scheduling the review meeting. During the review, the student should succinctly summarize the research progress and plan for thesis completion. An advance document of several pages should be provided, similar to the qualifying procedure. The committee is expected to provide on-the-spot feedback to the student so that all members are in agreement as to what still needs to be accomplished. No grade evaluation is to be given. Such reviews will be conducted annually thereafter until completion of the

thesis. A summary of the outcome of the review, signed by the student and the adviser, should be placed in the student's file.

I. The Thesis Defense/Final Examination

Each PhD candidate must successfully pass a Final Examination based principally on work presented in the dissertation. The examination is conducted by a faculty committee composed as prescribed for the Qualifying Examination; the same people normally serve on both committees. This examination is composed of a mandatory open and publicized oral presentation and discussion during the first hour followed by a closed examination with only the committee during the second hour.

A student is required to prepare a draft of a paper (on work performed here) suitable for publication as part of the requirements for the PhD degree. The Final Examination will be given only after the draft of the paper has been submitted to the adviser, and a memo signed by the adviser certifying this is on file in the department office.

Procedures:

Students should

a) Contact committee members to set date and time. Students do not necessarily need to be registered to defend.

b) Submit a draft of a paper for publication to the adviser.

c) Receive the adviser's approval that the dissertation is in final form and ready to be presented to the committee for review. ("Final form" means fully proofread. Faculty members are not expected to serve as proofreaders.)

d) Reserve a conference room. Give Sharon a title and abstract so that a public notice of the presentation can be posted. Supply names of committee members for submission to the Graduate School **at least three weeks** before the exam.

e) Note that the deadline for taking the exam and submitting the dissertation to the Graduate School for both June and December varies. Consult the timetable in the *Graduate School Bulletin* for exact dates each year.

f) Be reminded that the format of the dissertation must conform to standards established by The Graduate School and published in the booklet "Preparation and Submission of the Dissertation," except as noted in the following paragraphs. It is the student's responsibility to insure that the thesis meets these requirements.

The Department has obtained permission to use a **reference format** different from those specified in the booklet describing rules for thesis preparation distributed by The Graduate School. The additional option is as follows:

In the text, numbers denote references. These numbers must follow a numerical order throughout the entire text, except that second and later references to a work may carry the same number as the first citation. The numbers may be superscript or enclosed in brackets or parentheses. A numbered list of all references must be placed at the end of the text in a list entitled "References and Notes".

The Department further requires that titles and first and last page numbers be included in references. This requirement makes the list of references a much more useful document.

g) Present each examining committee member with a copy of the dissertation **at least ten days** before the examination.

h) After final approval, turn in one unbound copy of the dissertation to the Department office to be bound (at department expense) for the MSE collection. (Additional copies may be given to the office to be bound at the student's expense.) Also furnish the Department with a copy of the abstract. The Graduate School will require two unbound copies of both the dissertation and abstract.

i) Before final departure, see Sharon Jacknow. Complete the sign-out sheet, return borrowed items (theses, library books, etc.), properly dispose of all research chemicals, and be sure to leave a forwarding address with the Materials Science and Engineering Department office. Upon return of all keys, the key deposit will be returned.

V. GENERAL INFORMATION FOR MS AND PHD STUDENTS

A. Stipend Checks

All recipients of Research Assistantships or Fellowships must complete Employment Eligibility (I9) forms, the Federal W-4 and IL W-4 forms for the University. International students must complete the Alien Tax Status form also required by the U.S. Treasury Department. These forms are available in the Department Office. We will also need your Social Security Number for payroll purposes.

All checks are delivered to the Materials Science and Engineering Department Office on the last working day of the month. You may pick up your check in the Department Office. **Please note: To avoid financial problems at the beginning of Fall Quarter, all incoming students should be aware that you will not receive your first check until September 30th.**

Research Assistants: Since you do not start your University activities on the first of September, your first stipend check will include only that part of September you were here.

One month's tuition (\$590 for '02-'03) will be included in your first check. **You must pay this money to the University at the Student Finance Office, 619 Clark Street, by October 1st.**

You must sign up for payroll deductions of subsequent tuition obligations by September 30th. Sign-up is in the Department Office. Henceforth your check, which is comprised of your stipend and that portion of the monthly tuition bill charged to your research grant, will have the tuition deducted. Failure to sign up for tuition deductions would mean that you would have to pay the whole quarter's tuition in full before the due date. A fee of \$100.00 will be charged to any student who is late with his/her tuition payment.

Fellows: University Fellows will be paid for the full month of September, although you do not start your University activities until later in the month. The day of reckoning comes June 1st, when the extra days are recovered, i.e., **your June check will be reduced.** Subsequent checks **will be taxed** on the amount of tuition added to your stipend at the end of the fellowship.

Outside Fellows: In order to process supplements and stipends, we *must* have copies of your original

award letter and any renewal/adjustment letters in subsequent years.

Avoiding late fees: Tuition bills will be sent to your permanent address—in most cases your parents' address—often causing a delay resulting in a \$100.00 penalty fee. To avoid this, you need to complete a form (available in the Department Office) directing Student Finance to send your tuition bill to the Department Office. The bills will be checked over by Sharon Jacknow. If anything other than tuition is owed, the bill will be passed on immediately to the student for payment.

B. Research Registration

As described in the "General Degree Requirements" section of the *Graduate School Bulletin*, research registration is important for satisfying residency requirements and maintaining correct tuition levels. Doctoral candidates entering with a BS should enroll in 590 Research for nine quarters, followed by three quarters of 599, then 503 for the duration. (Outside fellows, see exception below.)

Those entering in the Fall with an MS have two options: (1) Six quarters of 590, three quarters of 599, then 503; or (2) Three quarters of 590, one quarter of 598, three quarters of 590, three quarters of 599, then 503, for those wishing to take courses in the spring of their second year (requiring 590).

Masters degree candidates should enroll in three quarters of 590 followed by 588.

These sequences are summarized in the Appendix. Also denoted are P, Q, and R representing Preliminary Evaluation, Qualifying Examination, and Residency Completion, respectively.

Note: Summer registration (usually 3 units of 590 until the Qualifying Exam) is mandatory for all students on university support (except departmental) or F1 or J1 visas. Students holding outside fellowships should check with Sharon Jacknow before summer registration to determine whether they are required to register for 598 rather than 590.

C. Pass/No-Credit Option

Students working toward an MS or a PhD in Materials Science and Engineering may **not** use courses taken on a P/N basis to satisfy course requirements. Graduate students may, with the approval of their adviser, take courses on a P/N basis *after* satisfying the departmental course requirements.

D. Academic Honesty

Students are strongly advised that originality is essential in all laboratory reports, term papers, exams, theses, etc. associated with graduate work. Students are required to do their own work. Ideas, data, or word-for-word quotations taken from other sources (*including the work of fellow students and other group members*) must be appropriately referenced; otherwise plagiarism will have been committed. The following statements should help define what is meant by "appropriately referenced":

a. All ideas, data, mathematical expressions, and word quotes taken from the works of others should be clearly and directly referenced to the original author. This is best accomplished by listing a reference number after the material with the numbered references appearing at the end of the manuscript. The following format is also acceptable:

"The equation can be derived following the approach of Jones³³ as follows:..."

b. Word for word quotes **must** have quotation marks at the beginning and end and be referenced in the manner described above.

c. Photocopied figures should be referenced as described in a. above.

d. Redrawn figures or plots made from other people's table of data can be appropriately labeled "after Smith⁴³".

e. Each person should receive proper recognition for contributions made.

In accordance with Graduate School regulations, "All cases of alleged academic dishonesty involving students of The Graduate School are to be referred by members of the faculty to the Dean of The Graduate School." A student found guilty of academic dishonesty runs the risk of being dismissed immediately from the graduate program.

Students will receive copies of *On Being a Scientist* by the Governing Board of the National Research Council and Northwestern University's *Guidelines for Investigators in Scientific Research*. These two documents discuss ethical standards in the scientific community. The Department expects the highest levels of integrity from students and faculty.

E. Work Obligation of Graduate Students and Other Limits on Outside Compensation

Students are expected to work on thesis research an average of no less than twenty hours per week while taking courses, and full time otherwise, for the research project from which the stipend, supplement and/or tuition are paid. Since all support monies are derived from government or industry contracts and grants, it is the students' responsibility to perform their assigned research tasks in a timely manner. It should be noted that most contracts require formal progress reports on the research performed.

Students are not to hold additional part-time jobs, except where there are exceptional extenuating circumstances and with the consent of the adviser and department chair.

Awards won by students based on work done in the department should be discussed with Joanna Gwinn so that an account can be set up for proper disbursement of the funds. If the award includes salary support, the project-derived stipend will be adjusted so that total support does not exceed that of the Cabell awards for the current year. However, the support from the research grant or contract cannot be less than the minimum specified for Graduate Research Assistant Tuition Scholarships. Other award money should be used to support the student's educational expenses; e.g., conference travel, books, computer purchases, etc. Accounting assistance is available from the department office if spending must be documented.

F. Vacation Policy for Graduate Students

Students receiving financial aid through the University (Research Assistantships, Fellowships, Teaching Assistantships) are entitled to staff holidays. Please note that the breaks between academic quarters, such as at Christmas and spring break, are not vacation periods. Paid vacation or excused absences must be arranged in advance with the faculty adviser. A paid vacation of two weeks per year is considered normal for a student making satisfactory progress toward a degree. If approval from the adviser is not obtained before taking any time off, loss of financial support may result. Students electing not to take vacation are not entitled to any extra compensation.

G. Ombudspersons

Webster's *New Collegiate Dictionary* (1973) defines an ombudsman as "one that investigates reported complaints (as from students or consumers), reports findings, and helps to achieve equitable settlements." Joanna Gwinn serves in this capacity at the department level and will deal confidentially with concerns of graduate students. McCormick School of Engineering has named Judy Hicks, Assistant to the Dean, as the School's Ombudsperson, and she is also available to discuss workplace conflicts between students, faculty, and staff. She is an appropriate person to turn to (along with Assistant Deans of Student Affairs Joe Holtgreive and Ellen Worsdall) where sexual harassment or discrimination is felt to be an issue.

H. Consumption of Alcoholic Beverages

Consumption of alcoholic beverages in the Materials/Life Science Building, except at official departmental functions and such recognized events as post-defense celebrations, is incompatible with sound safety and work-place practices and is therefore unacceptable. **We expect our students to abide by Illinois laws concerning all controlled substances.**

I. Student's File

Folders are kept in the department offices for each student. They contain application materials, approved study programs, grades for completed courses, records of completed examinations, names of committee members, current address, phone numbers, etc. In accordance with Government regulations a student is allowed access to his file after submitting a written request to the Department Assistant. Educational records cannot be released to any outside agency without the student's written consent. Students applying for credit cards, etc., which require employment and/or salary verification by the department, must sign a release form obtainable from the Department Assistant, Room 2043. Verification of employment may also be done through NU's Employment Verification Infoline. Details can be found at www.northwestern.edu/hr/hris.

J. Change of Address

The Department Office must be notified of any change of address. The student is required to complete a Personal Data Form obtainable in the department office, copies of which will be forwarded to the appropriate University offices.

K. International Students

All international students must register with the International Student Adviser, 630 Dartmouth Place, Evanston Campus, who will act as adviser on all matters concerning employment practice, visa renewals, etc.

L. Colloquium Series

The Department organizes, at considerable expense, the colloquium series, "Advances in Materials Science". Its primary purpose is to broaden the education of each graduate student by bringing to campus the leaders in our field. Attendance is required of all graduate students.

M. Safety

Although the University and faculty project advisers strive to maintain a safe working environment, students must continually be vigilant regarding safe laboratory practice and equipment. No amount of information and training can replace common sense on the part of the experimenter. If you are uncertain about the safety of a procedure, contact your faculty adviser, a member of the Department Safety Committee, or the Office of Research Safety, (1-5581).

The department has taken a number of steps to help provide a safe environment for your research. Each

incoming student is given a copy of *Is It Safe? A Safety Manual for Materials Science and Engineering* and the building emergency plans. **You must read this material carefully and retain it for future reference.** Safety glasses must be worn at all times when carrying out experiments in the laboratory or the shop. These are available through the Chemistry Storeroom or your adviser. Prescription safety glasses and lab coats are available, free of charge, through your adviser. Handbooks of dangerous materials and lists of biohazardous/carcinogenic chemicals are available from Research Safety in Tech NG71, and from your adviser. Attendance at occasional department safety meetings is required.

Special safety procedures apply to the Instrument Shop. Students are encouraged to use certain shop equipment provided they are familiar with the equipment. Check with your adviser for current information.

N. Keys

Graduate students will receive keys for Cook Hall, the outside doors of Tech Institute, for their laboratory and office, and for Room 2032 (student mailboxes). In order to get your keys, you must obtain an application in the Department Office, to be filled out and returned to Joanna Gwinn with a key deposit of \$15.

Students working on research projects may be issued keys to project laboratories (from MSE office) and MRC central facilities (from the MRC Office in K111 Tech) upon approval of the faculty member responsible for that laboratory. **Keys must not be passed on to anyone else.**

Students are not to enter the office of a faculty member at any time when the faculty member is not present, and students may not be in the Department Office after normal working hours.

O. Computer/Design Labs

Computers (both Mac and PCs) are available for individual use in the Undergraduate Teaching Lab in Cook 2068 and the Bodeen-Lindberg Materials Design Studio in Tech C11. However, they are not meant to substitute for the computers that should be found in an adequately equipped research group. Access is generally limited: classes and MSE undergraduates are given first and second priority use of the machines, respectively, and the room is unavailable during lab periods. The facility is intended for academic use only. New students are assigned a userid based on their NU netid. Other individuals who require access may submit their request to the lab manager, Dr. Kathleen Stair in Cook 2008. Dr. Stair must be consulted prior to addition or deletion of any software or hardware on these systems, or in the event of system malfunctions. Access to the labs after hours is by your Marlok building key (Cook 2068) or an access code for a numeric pad (Tech C115).

P. Desk and Research Space Assignment

A desk for personal use will be assigned to each graduate student once the permanent adviser has been assigned. The assignment of both desk and research space are handled by your adviser; please see him or her concerning any move you wish to make. Then you must inform the Department Office of your new room number. No changes should be made without your adviser's authorization.

Q. Telephone and Mail Service

Note that the Department is charged for local calls. **Therefore, personal calls should be made on public phones.** Each laboratory is provided with a telephone for calls connected with University business.

Long distance calls require an access code. Students may be assigned their own codes, but approval for this

must be given to Sharon Jacknow in writing by the adviser. Personal long distance calls should be made on calling cards, but if made on access codes **should be reimbursed** upon presentation of the bill from your group secretary. Persons who may have occasion to call you from outside the University should be given the telephone number of your lab (alternatively, your adviser's phone number). The secretary will attempt to contact you, or if this is not possible, will take a message. **Collect calls are not acceptable, by Northwestern regulations.**

U.S. Postal Service. Mail is delivered once a day to the Department Office around lunchtime. The student mailboxes are in Cook 2032; you will find your mail and messages in your assigned box. It is advisable to check your mailbox *daily*. Use of the University mailing address for personal mail is not allowed by NU regulations. The US mail basket in the office is for university business only.

R. Photocopying, Copy Cards, and Faxing

Photocopying machines are available in the Department Office and in the north corridor of the third floor of Cook Hall. A user code, which can be obtained from Sharon Jacknow, is required. Copy cards for use in copying machines at the library are available through the Wildcard Office or at Seeley Mudd Library. Photocopying services are also located at Norris Center and 2020 Ridge for large orders. ***You must have the permission of your faculty adviser to charge copies to a grant.***

A fax machine is located in the Department Office. Fill out forms located next to the machine with billing information. Long distance faxes require an access code. See Andrea DiVincenzo for personal faxes.

S. Automobile Regulations

The University Police Parking Division controls the NU parking lots. Students requiring a sticker which will enable them to park in the various University parking lots should obtain an application from the Parking Office located at 1819 Hinman, Evanston (open Monday through Friday, 8:15 A.M. to 4:15 P.M.). Applications are issued upon presenting your University I.D. card, driver's license and payment of a fee. Additional information can be found at <www.northwestern.edu/up/parking>. ***Argonne and other off campus students must obtain daily parking stickers for \$4.50 from the Department Office if they choose not to purchase the yearly sticker.***

For your information, *all students who park cars on campus* are required to register the car with the Parking Office. Bicycles should also be registered (Fee: \$1.00).

Students working at Argonne are eligible for mileage reimbursements. Request a Travel Expense form from the office.

T. Purchases

Orders for outside purchases in connection with your research are initiated by filling out a "goldenrod" request form. A supply of these forms is kept in the Department Office. Include the CUFS account number to be charged, vendor information (name, address, phone, and fax number), description of goods to be ordered, and prices. Indicate whether the order is to be faxed or mailed to the vendor. Print your name and phone number at the bottom of the form and have your adviser sign the goldenrod.

After your adviser approves this form, the Department Office will enter an official University purchase request. For orders under \$25,000, the staff of the Purchase Order Processing System (POPS) will then process the order. Special forms must accompany all orders over \$25,000 showing that the order was competitively bid. Single-source justification forms must accompany large purchases that for whatever

reason cannot be competitively bid. Forms are available in the office.

It is important that no order, or promise of an order, be given to any vendor except by POPS or the Purchasing Department. Phone orders by students are strongly discouraged.

If the material ordered is carried in stock by the supplier, normal processing should result in delivery between a few days and a few weeks from the time your request is submitted. Naturally this time will increase if the supplier cannot make immediate delivery when he/she receives the order.

In case of emergency orders, convey special shipping instructions, fax information, etc., to the department staff so that the order can be expedited.

Ordered items are delivered to the Materials Science and Engineering Department Office. You will then be notified of delivery and asked to collect the package as soon as possible. ***The packing slip must be signed indicating whether the order is complete or otherwise, and turned in immediately to the Department Office (Room 2036).*** The supplier will not be paid until the department acknowledges receipt of the merchandise.

In the event of unreasonable delay in delivery of an item, it can be traced through the Purchase Order number. The Department Office can help you in this matter. When returning a purchase, it is important to inform the accounting clerk. See the handout "Strategies for Successful Purchasing" for additional information on how to avoid or deal with problem orders.

U. Petty Cash and Reimbursements

Small emergency orders (less than \$25.00) may be handled by petty cash. **Obtain your adviser's permission before you make this type of purchase.** When you buy the material be sure you receive an itemized receipt from the store (cash register receipts or credit card statements alone will not be accepted), and then fill out a petty cash form in duplicate. This is then signed by the Department Chair or student's adviser. The original is taken to the Department Office for reimbursement.

The University is exempt from Illinois Sales Tax. A Sales Tax Exemption form is available in the department office, to be used to apprise stores that your purchase is for Northwestern so that tax will not be charged. **We are not permitted to reimburse state taxes.**

A reasonable amount of forethought can eliminate most of the necessity for emergency orders and petty cash purchases. Abuse of these procedures will only result in additional restrictions on their use. Petty cash slips will not be approved in cases where an attempt is made to circumvent the \$25.00 limit by splitting the purchase on several slips. Such cases may be handled only by writing a requisition for reimbursement.

Reimbursement for larger purchases is initiated by filling out a purple Request for Reimbursement form, available in the office, and returning it with receipts and signatures to Tamika Smith. **Again, we do not reimburse sales tax.**

V. Services and Supplies in Tech

Please note that most facilities have usage fees. Students must have the permission of their advisers before charging any time on equipment or obtaining supplies from any storerooms. Make sure accounts used are active and proper object codes are open before charging.

1. University Instrument Shop (NG40): Graduate students in the Materials Science Department will find that the machine shop plays an important role in the conduct of their thesis research. The Shop Foreman will be happy to help students with problems relating to machining or participation in the student shop program.

2. Physics Student Shop (NG36): The Physics Department maintains a Student Shop next to the University Instrument Shop. Because the professional staff is often overloaded with work, and because many machining jobs are simple, students are encouraged to make use of the student shop program. Safety rules must be **strictly obeyed**. Failure to do so may result in denial of all further access to the shop facilities. Please check with the Shop Foreman for training and further information. OSHA regulations require that safety glasses be worn at all times while in the shop. **This policy will be enforced.**

3. Assorted Gases: These can be obtained by calling 3-8840 with your CUFS number and location. Most common gases (air, ammonia, argon, CO₂, helium, hydrogen, nitrogen and oxygen) will be delivered within 24 hours. **All tanks other than "S" are demurrage tanks for which we pay a monthly rental fee, whether the tank is in use or not.** It is therefore important that all empty tanks be returned immediately.

4. Glassblowing Shop: Located in Tech KB21 and open from 8:30 A.M. to 4:00 P.M. daily.

5. Electronics Shop: Approval of your adviser is required. Be sure to enter proper CUFS number on the form that is available in the shop, Tech NG50.

6. Chemical Supplies: Supplies are available at the Chemistry Stockroom (KG44). Approval of your adviser is required. Be sure to supply the proper CUFS number.

7. Purchasing Stores: The Purchasing Department maintains a stock of many common office, aintenance and other supplies. A catalogue of these items is on file in our Department Office. mOrders should be placed through the group's secretary.

W. The Materials Science Student Association (MSSA)

The MSSA was established in 1960 as the Student Chapter of ASM/AIME. Jointly with the undergraduates' Materials Science Club, it is an official student chapter of ASM and TMS-AIME. Each year (usually at the end of the Spring Quarter) an election is held to fill the offices of President, Vice President, Secretary/Treasurer, Activities Chairman, and Faculty Representative. The Officers serve as liaison to the Faculty and Department administration in representing the students' interests. They also organize various social and professional activities throughout the year. Students are automatically members and are encouraged to participate. For international students the club provides valuable interaction for the development of English proficiency. Professor Steve Carr is the Materials Science Student Association faculty adviser for 2002-2003.

X. Bike Riding and Skateboarding

For obvious safety reasons, bike riding and skate boarding are prohibited in the corridors of Tech and MLSB. **In addition, bikes may not be stored in labs or in public spaces in the building.**

APPENDICES

2002-03 Department Teaching Schedule

Study Plan

Research Registration

Preparation for Core Course Form

Core Course Waiver Form

Request for Qualifier Form

Request for Final Defense Form

TABLE OF CONTENTS

	Page
I. TEMPORARY ADVISERS	1
II. PERMANENT ADVISERS	1
A. Selection Process	1
B. The Faculty Adviser's Role and Student's Study Plan	2
III. MS DEGREE REQUIREMENTS	2
A. MS with Thesis	2
B. Courses-Only MS Option	3
C. Part-time Students	4
IV. PhD DEGREE IN MATERIALS SCIENCE & ENGINEERING	4
A. Residency and Course Load	4
B. Research	4
C. Course Requirements:	4
1. Students Entering with BS Degree	4
a. Core Courses in Materials Science & Engineering	5
b. Minor Field of Study	6
c. Business and Communications	6
2. MS/PhD Program	6
3. Students entering with MS Degree	7
D. Teaching Assistant Requirement	7
E. The Preliminary Evaluation	8
1. Students Entering with BS Degree	8
Research Report	8
2. Students Entering with MS Degree	8
3. MS/PhD Students	8
4. Part-time PhD Students	9
F. The Qualifying Examination	9
1. Time Requirements	9
2. Qualifying Exam Procedure and Committee Makeup	9
3. English Language Requirement	10
G. Crown Family Graduate Internship	10
H. Post-Qualifier Reviews	10
I. The Thesis Defense/Final Examination	11

V.	GENERAL INFORMATION	12
	A. Stipend Checks	12
	B. Research Registration	13
	C. Pass/No Credit Option	13
	D. Academic Honesty	13
	E. Work Obligation of Graduate Students	14
	F. Vacation Policy for Graduate Students	14
	G. Ombudsperson	15
	H. Consumption of Alcoholic Beverages	15
	I. Student's File	15
	J. Change of Address	15
	K. International Students	15
	L. Colloquium Series	15
	M. Safety	15
	N. Keys	16
	O. Computer Lab	16
	P. Desk and Research Space Assignments	16
	Q. Telephone and Mail Service	17
	R. Photocopying, Copy Cards, and Faxing	17
	S. Automobile Regulations	17
	T. Purchases	17
	U. Petty Cash and Reimbursements	18
	V. Services and Supplies in Tech	19
	1. University Instrument Shop	19
	2. Physics Student Shop	19
	3. Assorted Gases	19
	4. Glassblowing Service	19
	5. Electronics Shop	19
	6. Chemical Supplies	19
	7. Purchasing Stores	19
	W. Materials Science Student Association	19
	X. Bike Riding and Skateboarding	19

APPENDICES

September 1, 2002

TO: Incoming Graduate Students

Welcome to our Department!

This booklet is prepared to aid you in your educational and research endeavors. Please read it carefully and be aware of the requirements and responsibilities described. The information supplied herein is more specific than that in the *Graduate School Bulletin*. You should also familiarize yourself with the general regulations of The Graduate School.

We hope your stay with us will be a most rewarding and pleasant experience. I look forward to getting to know you and working with you. I am always (well, almost always) available to help you with problems and to discuss your life at Northwestern. Please feel very free to come in to see me.

Katherine T. Faber
Professor and Chair

**INFORMATION FOR GRADUATE STUDENTS
IN MATERIALS SCIENCE AND ENGINEERING
2002-2003**