Key to Course Listings

Catalog numbers are part of a University-wide numbering system. Generally, courses numbered 100 to 199 are introductory, 200-299 are intermediate, and 300-499 are advanced (upper-level).

Reorganized or renumbered courses are denoted by a parenthetical number in boldface following the course number. When renumbering or reorganization has left the SUBJECT unchanged, only the previous catalog number is given; if the SUBJECT has also changed, the previous SUBJECT name and course number appear. A reorganized or renumbered course cannot be repeated for credit without special permission.

Cross-listed courses are sponsored by more than one department or program and may be elected in any of the participating units. Cross-listings appear in boldface and are denoted by a slash between the participating units.

Course titles appear in boldface after the catalog number.

Prerequisites appear in italics after the course title. Some prerequisites are advisory. They suggest the assumed background or level of academic experience, and students should be guided by these statements. Some prerequisites are mandatory and are enforced at the point of registration. The *Course Guide* and the *LS&A Bulletin* indicate the cases when prerequisites are enforced.

Prerequisites are of three types:

- *Courses.* Unless otherwise stated, the phrase "or equivalent" may be considered an implicit part of the prerequisite for any course. When a student has satisfactorily completed a course(s) at the required level of competency and when that course is believed to be substantially equivalent to one listed as a prerequisite, the student must consult the instructor or department. If equivalency is determined to have been satisfied, election may be approved by issuance of electronic permission.
- *Class standing* (first year, sophomore, junior, senior). A course might be appropriate for "first and second year students only," or for "juniors and seniors."
- *Permission of instructor.* The phrase "or permission of instructor" may be considered an implicit part of the statement of prerequisites for any course. When permission is a stated requirement, or when a student does not have the stated prerequisite for a course but can give evidence of sufficient background, the student should obtain approval from the instructor or department concerned and an electronic permission issued.

The Credit Symbol, an Arabic numeral in parentheses, denotes the credits earned for the course. Credit is granted in semester hours. Except for small seminars where the reading and/or writing requirements are intensive, one credit represents no less than one hour of class meeting time each week of the term, and usually represents two hours of work outside of class for each class hour.

Area distribution designation is approved by the LS&A Curriculum Committee on a yearly basis. A course may be approved with the designation natural science *(NS),* social science *(SS),* humanities *(HU),* mathematical and symbolic analysis *(MSA),* creative expression *(CE),* interdisciplinary *(ID),* or excluded from distribution *(Excl).*

Courses meeting certain college requirements are so listed. Language other than English *(LR)* courses may be used toward meeting the Language Requirement. The First-Year Writing Requirement may be met by courses designated (Introductory Composition). Courses approved with the designation "Language Requirement" or "Introductory Composition" may not be used as part of an area distribution plan. If an introductory language course is designated "Excluded" *(Excl),* it may not be used to satisfy the LS&A language requirement. *(BS)* means that the course may be used toward the 60 approved credits required for the B.S. degree. Courses meeting or partially meeting the Quantitative Reasoning requirement are designated *(QR/1)* or *(QR/2).* Courses with standard approval for meeting the Race & Ethnicity *(R&E)* requirement are so indicated. Other courses may meet the R&E or QR requirements on a term-by-term basis and are listed on the LS&A website (http://www.lsa.umich.edu/).

Experiential, Independent Study, and Tutorial courses are so designated. (See Experiential and Directed Reading/Independent Study Courses in *Chapter IV.*)

Repetition of a course that varies in content from term to term is permitted only under certain conditions. When a department or program has a policy about the repetition of a course for credit, that policy is included in the course listing. The general statement "May be repeated for credit with permission" usually means "With permission of a concentration advisor." In all other instances, a student must get permission from both the department or program and the Academic Standards Board to repeat a course for credit. Generally, a course may be elected for credit once only.

Excluded combinations of course elections are designated in the listing of affected courses.

Special Grading pattern for a course is indicated in the course listing. Some LS&A courses are offered *mandatory credit/no credit.* (See Non-Graded Courses in *Chapter IV.*)

The Term Symbol, a Roman numeral, denotes the term(s) some courses are offered. The University year is divided into three terms: Fall (I), Winter (II), and Spring-Summer (III). The Spring-Summer Term is further divided: Spring-Half (IIIa) and Summer-Half (IIIb).

Courses That Count Toward Graduate Programs

Courses Approved for Regular Rackham Graduate Credit. All courses taken in fulfillment of Rackham degree requirements must be approved for Rackham graduate credit. Be certain that any courses you plan to take--especially those numbered in the 400s--are approved for Rackham credit before you enroll in them. The Graduate School policy on courses is as follows: Courses at the 400 level and above are acceptable for graduate credit if they have been approved by the Graduate School.

If you are uncertain whether or not a course is approved for Rackham credit, check with the department offering the course or with the Rackham Course Approval Officer (764-8221).

If you elect a course that has not been approved for Rackham graduate credit, the course will appear on your university transcript with the notation "Not for Graduate Credit. The course grade will appear on the transcript, but it will not be averaged into your cumulative grade point average or your credit toward program (CTP) total.

Courses Not Approved for Graduate Credit. Courses at the 300 level and below are not acceptable for graduate credit, without exception. Undergraduate level foreign language courses may occasionally be used in fulfillment of some departmental foreign language requirements.

Under unusual circumstances you may petition to receive graduate credit for a course not normally approved for graduate credit *(e.g.,* such as an undergraduate course where you will be expected to perform more advanced work than the undergraduates). Because there is no guarantee of approval, you should submit your petition to the Graduate School's Office of Academic Records and Dissertations (OARD) before taking the course. Your petition must be endorsed by the course instructor and by the graduate chair of your department or program, and it must include an explanation for requesting the exception. You will be expected to perform graduate level work in the course, and the petition must show how this will be accomplished. You may obtain a petition form from your department, from OARD, or online .

April 7, 2006

Macromolecular Science and Engineering Center

Macromolecular Science and Engineering

Macromolecular Science MACROMOL 425

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http://www.engin.umich.edu/prog/macro/

Undergraduate and Graduate Courses

410 **MACROMOL 410 / BIOMEDE 410 / MATSCIE 410.**
Design and Applications of Biomaterials.
(4;4) : May not be repeated for credit.
(Excl). (BS).
MATSCIE 220 or 250. I.
Biomaterials and their physiological interactions.
Materials used in medicine/dentistry: metals, ceramics, polymers, composites, resorbable, smart natural materials.
Material response/degradation: mechanical breakdown, corrosion, dissolution, leaching, chemical degradation, wear.
Host responses: foreign body reactions, inflammation, wound healing, carcinogenicity, immunogenicity, cytoxicity, infection, local/systematic effects.

412 **MACROMOL 412 / CHE 412 / MATSCIE 412.**
Polymeric Materials.
(3;3) : May not be repeated for credit.
(Excl). (BS).
MATSCIE 220 or 250, and CHEM 210 with a grade of C- or better; or graduate standing (Prerequisites enforced at registration). CAEN lab access fee required for non-Engineering students. I.
The synthesis, characterization microstructure, rheology, and processing of polymeric materials. Polymers in solution and in the liquid, liquid-crystalline, crystalline, and glassy states. Engineering and design properties including viscoelasticity, yielding, and fracture. Forming and processing methods. Recycling and environmental issues.

414 **MACROMOL 414 / CHE 414 / MATSCIE 414 / MFG 414.**
Applied Polymer Processing.
(3;3) : May not be repeated for credit.
(Excl). (BS).
MACROMOL 412 or MATSCIE 412 or CHE 412 with a C- or better; or graduate standing (Prerequisites enforced at registration). CAEN lab access fee required for non-Engineering students. II.
Theory and practice of polymer melt processing. Non-Newtonian flow, extrusion, injection molding, fiber, film, and rubber processing. Kinetics of and structural development during solidification. Physical characterization of microstructure and macroscopic properties. Component manufacturing and recycling issues, compounding and blending.

512 **MACROMOL 512 / CHE 512 / MATSCIE 512.**
Polymer Physics.
(3,3;3,3) : May not be repeated for credit.
(Excl). (BS).
Senior or graduate standing in engineering or physical science. CAEN lab access fee required for non-Engineering students.
Structure and properties of polymers as related to their composition, annealing and mechanical treatments. Topics include creep, stress relaxation, dynamic mechanical properties, viscoelasticity, transitions, fracture, impact response, dielectric properties, permeation, and morphology.

514 **MACROMOL 514 / MATSCIE 514 / MFG 514.**
Composite Materials.
(3,3;3,3) : May not be repeated for credit.
(Excl). (BS).
MATSCIE 350. CAEN lab access fee required for non-Engineering students. I.
Behavior, processing, and design of composite materials, especially fiber composites. Emphasis is on the chemical and physical processes currently employed and expected to guide the future development of technology.

515 **MACROMOL 515 / MATSCIE 515.**

Mechanical Behavior of Solid Polymeric Materials.

(3,3;3,3) : May not be repeated for credit.

(Excl). (BS).

MECHENG 211 and MACROMOL 412. CAEN lab access fee required for non-Engineering students.

The mechanical behavior of polymers from linear viscoelastic to yield and fracture are covered. Specific topics include dynamic-mechanical relaxations, creep, yielding, crazing, fatigue, and fracture mechanics. The materials include toughened plastics, polymer alloys and blends, and composite materials. Structured design with plastics is also considered.

536 **MACROMOL 536 / CHEM 536.**

Laboratory in Macromolecular Chemistry.

(2;2) : May not be repeated for credit.

(Excl). (BS).

CHEM 535 or PHYSICS 418. Laboratory fee ($50) required.

Experimental methods for the study of macromolecular materials in solution and in the bulk state.

538 **MACROMOL 538 / CHEM 538.**

Organic Chemistry of Macromolecules.

(3;3) : May not be repeated for credit.

(Excl). (BS).

CHEM 215/216, and CHEM 230 or 260.

The preparation, reactions, and properties of high molecular weight polymeric materials of both natural and synthetic origin.

Graduate Courses

517 **MACROMOL 517 / MECHENG 517.**

Mechanics of Polymers I.

(3,3) : May not be repeated for credit.

(Excl). (BS).

MECHENG 511 and Graduate standing. CAEN lab access fee required for non-Engineering students.

Viscoelastic stress-strain relations; generalized creep and relaxation models, operational approach. Correspondence between viscoelastic and elastic solutions of boundary value problems. Three dimensional theory of linear viscoelastic media. Quasi-static problems; sinusoidal oscillation problems; use of complex modulus and compliance; dynamic problems, impact.

690 **MACROMOL 690.**

Integrated Graduate Education and Research Training Program (IGERT) Research Rotation.

(3,3) : May not be repeated for credit.

(Excl). (INDEPENDENT).

Graduate standing. This course has a grading basis of "S" or "U."

A three-term Research Rotation in the research groups of participating faculty from different departments, and possibly industry or government laboratories. Students will conduct research in a laboratory setting.

790 **MACROMOL 790.**

Faculty Activities Research Survey.

(1,1) : May not be repeated for credit.

(Excl). (INDEPENDENT).

Graduate standing.

This course introduces students to the research activities of Macromolecular Science faculty with the intent of helping a student to choose his research advisor in the first term.

800 **MACROMOL 800.**

Macromolecular Seminar.

(2,2) : May not be repeated for credit.

(Excl).

Graduate standing.

Selected seminar topics in macromolecular science and engineering given by the student.

890 **MACROMOL 890.**

Introduction to Research Techniques.

(1-8,1-4) : May not be repeated for credit.

(Excl). (INDEPENDENT).

Consent of instructor required (Prerequisites enforced at registration). Approval of graduate committee. Graduate standing.

This course is used for research carried out to earn the Master's Degree.

990 **MACROMOL 990.**

Dissertation/Precandidate.

(1-8,1-4) : May be repeated for credit.

(Excl). (INDEPENDENT).

Election for dissertation work by doctoral student not yet admitted as a Candidate. Graduate standing. This course has a grading basis of "S" or "U."

Election for dissertation work by doctoral student not yet admitted as a Candidate.

995 **MACROMOL 995.**

Dissertation/Candidate.

(8,4) : May be repeated for credit.

(Excl). (INDEPENDENT).

Graduate School authorization for admission as a doctoral Candidate (Prerequisites enforced at registration). This course has a grading basis of "S" or "U."

Graduate School authorization for admission as a doctoral Candidate. N.B. The defense of the dissertation (the final oral examination) must be held under a full term Candidacy enrollment period.