

## 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.

## Center for the Study of Complex Systems

### Complex Systems

#### Complex Systems CMPLXSYS 348

LSA

Center for the Study of Complex Systems

Complex Systems

<http://www.cscs.umich.edu/>

#### Undergraduate and Graduate Courses

##### 541 **CMPLXSYS 541 / PHYSICS 413.**

**Introduction to Nonlinear Dynamics and the Physics of Complexity.**

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

(Excl). (BS).

*PHYSICS 401 (Prerequisites enforced at registration).*

An introduction to non-linear science with an elementary treatment from the point of view of the physics of chaos and fractal growth.

#### Graduate Courses

##### 501 **CMPLXSYS 501.**

**An Introduction to Complex Systems.**

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

(Excl). (BS).

*Graduate standing or permission of instructor.*

This course covers a broad range of fundamental topics relevant to the study of complex systems. Topics covered include evolutionary systems, self-organized criticality, measures of complexity, approaches to modeling complex adaptive systems, and emergence. Authors covered include Holland, Barabasi, Wolfram, Axelrod, Kauffman, Bak, and Gell-Mann.

##### 510 **CMPLXSYS 510 / MATH 550.**

**Introduction to Adaptive Systems.**

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

(Excl). (BS).

*MATH 215, 255, or 285; MATH 217; and MATH 425, and permission of instructor. Working knowledge of calculus, probability, and matrix algebra.*

Centers on the construction and use of agent-based adaptive models. Course begins with classical differential equation and game theory approaches, and then focuses on the theory and application of particular models of adaptive systems such as models of neural systems, genetic algorithms, classifier systems, and cellular automata.

##### 530 **CMPLXSYS 530.**

**Computer Modeling of Complex Systems.**

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

(Excl). (BS).

*Enrollment in certificate program or permission of instructor.*

Introduces students to basic concepts, tools, and issues which arise using computers to model complex systems. Emphasis is placed on the modeling process itself, from model design through implementation to analyzing, documenting, and communicating results. Case studies of computer models of complex systems, including adaptive and non-adaptive complex systems drawn from economics, ecology, immunology, epidemiology, evolutionary biology, political science, and cognitive science.

##### 531 **CMPLXSYS 531.**

**Basic Computing Skills for Programming Agent Based Models.**

(1-2,1-2) : May not be repeated for credit.

(Excl). (BS).

This course covers the basic computing skills which are required for implementing agent-based models using Swarm (and other similar packages) in a LINUX/UNIX environment, including (a) basic LINUX/UNIX commands, (b) basic programming concepts (variables, operators, flow-control), (c) creating simple C and objective C programs and (d) basic Object-Oriented Programming concepts. For students intending to take CMPLXSYS 530.

535 **CMPLXSYS 535 / PHYSICS 508.****Theory of Social and Technological Networks.**

(3) : May not be repeated for credit.

(Excl). (BS).

*Calculus and linear algebra; some computer programming experience recommended.*

Introduces and develops the mathematical theory of networks, particularly social and technological networks; with applications to important network-driven phenomena in epidemiology of human infections and computer viruses, cascading failure in grids, network resilience and opinion formation. Topics covered: experimental studies of social networks, WWW, Internet, information, and biological networks.

599 **CMPLXSYS 599.****Independent Study of Complex Systems.**

(1-3,1-3) : May not be repeated for credit.

(Excl). (INDEPENDENT).

*Graduate standing and permission of instructor.*

Directed readings or research in consultation with a member of the faculty in Complex Systems.

899 **CMPLXSYS 899.****Special Topics in Complex Systems.**

(1-4,1-3) : May be elected up to three times for a maximum of 9 credits. May be elected more than once in the same term.

(Excl).

*Graduate standing.*

Interdisciplinary special topics course offered on the subject of Complex Systems. The course will expose students to expertise, techniques, and ideas that they would not find elsewhere on campus. Taught by visiting interdisciplinary specialists who are in-residence at UM.