SCIENTIFIC COMPUTING AND COMPUTATIONAL MATHEMATICS PROGRAM

Director: Walter Murray

Faculty: Juan Alonso (Aeronautics and Astronautics), Kyeongjae Cho (Mechanical Engineering), Eric Darve (Mechanical Engineering), Robert Dutton (Electrical Engineering), Ronald Fedkiw (Computer Science), Margot Gerritsen (Petroleum Engineering), Peter Glynn (Management Science and Engineering), Gene Golub (Computer Science), Joseph B. Keller (Mathematics, emeritus), Sanjiva K. Lele (Aeronautics and Astronautics), Doron Levy (Mathematics), Walter Murray (Management Science and Engineering), Joseph Oliger (Computer Science, emeritus); Peter M. Pinsky (Mechanical Engineering), Michael A. Saunders, (Management Science and Engineering)

Affiliated Faculty: Khalid Aziz (Petroleum Engineering), S. Boyd (Electrical Engineering), J. Cioffi (Electrical Engineering), R. Cottle (Management Science and Engineering), T. Cover (Electrical Engineering), G. Dantzig (Management Science and Engineering, emeritus), A. Dembo (Mathematics and Statistics), S. Doniach (Applied Physics and Physics), D. Donoho (Statistics), C. Eaves (Management Science and Engineering, emeritus), Joel Ferziger (Mechanical Engineering),J. Friedman (Statistics), Thomas J. Hughes (Mechanical Engineering, I. Johnstone (Statistics and Health Research and Policy), Thomas Kailath (Electrical Engineering, emeritus), J. Koseff (Civil and Environmental Engineering), K. Law (Civil and Environmental Engineering), T. P. Liu (Mathematics), R. MacCormack (Aeronautics and Astronautics), P. Moin (Mechanical Engineering), A. B. Owen(Statistics), W. Reynolds (Mechanical Engineering, emeritus), B. Roth (Mechanical Engineering), Eric Shaqfeh (Chemical Engineering and Mechanical Engineering), C. Steele (Mechanical Engineering and Aeronautics and Astronautics), R. Street (Civil and Environmental Engineering and Mechanical Engineering)

Web site: http://www-sccm.stanford.edu

Courses given in Scientific Computing and Computational Mathematics have the subject code SCCM. For a complete list of subject codes, see Appendix B.

The Scientific Computing and Computational Mathematics Program (SC/CM) is interdisciplinary and leads to the M.S. and Ph.D. degrees. It is designed for students interested in studying and developing computational tools in those aspects of applied mathematics central to modeling in the physical and engineering sciences. Graduates of this program are expected to be able to deal with a scientific problem from its formulation, moving through its mathematical analysis to algorithm development and implementation. The symbiosis of applied mathematics and numerical computing is stressed.

GRADUATE PROGRAMS

MASTER OF SCIENCE

The University's basic requirements for the M.S. degree are discussed in the "Graduate Degrees" section of this bulletin.

A candidate must complete a program of 45 units of courses numbered 100 or greater. In addition, a number of courses at the 200 level or above are required. At least 36 of these units must be graded units, passed with a grade point average (GPA) of 3.0 (B) or better. The core curriculum is common to all degrees offered by the program, but is adapted according to the interests and prior education of the student. Deviations from the core curriculum must be justified in writing and approved by the student's adviser and the SC/CM Committee. Courses that are waived rather than taken may not be counted towards the master's degree. The student must fulfill credit requirements in each of the categories listed below.

CORE CURRICULUM

1. *Mathematics* (15 units): students are required to take MATH 220A,B for a letter grade. Nine additional units in math are required with at least 6 units at the 200 level. Suggested courses are MATH 173, 205A,B,C, 220C, 224, 230, 236, 237, 256A,B,C, 274, 276A,B; STATS 300A,B,C, 305, 306A,B, 310A,B,C. Other courses from Statistics can be substituted with consent of the adviser and the SC/CM Committee. Students should take those courses most suitable to their areas of specialization.
2. *Numerical Analysis* (12 units): students are required to take CS 237A,B,C and an advanced course in numerical analysis such as: CS 335, 336, 337; MS&E 312; ME 233B, 235A,B,C; STATS 327. All 12 units must be for a letter grade.
3. *Optimization* (3 units): students are required to take MS&E 315.
4. *Computer Science* (5 units): students can select their courses, but must get approval for their selection from their adviser.
5. *Application Area* (9 units): students must take a focused program in an applications area such as fluid mechanics, operations research, or statistics. Courses must be at the 200 level or higher, and the program of concentration must be approved by the adviser and committee. Examples of suitable courses are: AA 210A,B, 214A,B,C; EE 363, 364, 365, 378A,B; ME 238A,B, 251A,B, 269.
6. *Seminar* (1 unit): students are required to regularly attend the Scientific Computing/Computational Mathematics seminar for one quarter. The seminar is held weekly during the academic year.

DOCTOR OF PHILOSOPHY

The University's basic requirements for the Ph.D. degree (residence, dissertation, examination, etc.) are discussed in the "Graduate Degrees" section of this bulletin. The following are the program's requirements:

1. Plan and successfully complete a coherent program of study covering the basic areas of Scientific Computing and Computational Mathematics. It must at least satisfy the requirements for the M.S. degree in SC/CM. It is important that the student be able to exhibit depth in some area of application. The student's adviser has the primary responsibility for the adequacy of the program, which must meet the approval of the SC/CM Committee.
2. To be admitted to candidacy for the Ph.D. degree, a student must have successfully completed 27 units of graduate courses (200 level and above) and at least a 3.3 GPA in the courses. In addition, a student must pass a qualifying examination and choose a thesis adviser. The qualifying exam is set twice a year, in September and June. Students entering in September may take the exam immediately, but must take it by the following September. This enables a maximum of 3 attempts. The exam is in 3 parts, each of 3 hours. Broadly speaking, Part 1 is based on CS 237A and MS&E 315, Part 2 on MATH 220A,B, and Part 3 on CS 237B,C. A student who, on entering, passes a particular part is excused from taking the corresponding courses.
3. Beyond the requirements for candidacy, the student must complete a focused course of study of at least 48 units. The program should be designed to develop a deep, focused background in the research area to be pursued in the dissertation. Approval of the program must be obtained from the SC/CM Committee.
4. In addition, the student must have an adequate knowledge of a coherent area of application and must complete at least 12 units in that area.
5. The most important requirement for the Ph.D. is the dissertation. A reading committee must be selected before the student is admitted to Terminal Graduate Registration (TGR), and this committee should be frequently consulted by the student before the University oral examination. Upon completion of a draft of the dissertation, the student must pass a University oral examination in defense of the dissertation.

Ph.D. MINOR

Students wishing to obtain a Ph.D. minor in the Scientific Computing and Computational Mathematics Program should consult the department office for designation of a minor adviser. A minor in SC/CM may be obtained by completing 20 units of course work, including the sequences MATH 220A,B, MS&E 315, and CS 237A,B,C; a GPA of 3.3 or better must be maintained in these courses.

A student may choose any adviser, but approval of the director is required if the proposed adviser is not a member of Stanford Academic Council (all Stanford faculty are members). At least one member of the reading committee must be a full SC/CM faculty. If the adviser is not a full SC/CM faculty, then approval of the student's committee is required.

COURSES

SCCM 137. Introduction to Scientific Computing—(Enroll in CS 137.)
3-4 units, Win (Golub)

SCCM 138. Matlab and Maple for Science and Engineering Applications—(Enroll in CS 138.)
3-4 units, Win (Moler)

SCCM 220A,B. Partial Differential Equations of Applied Mathematics—(Enroll in MATH 220A,B.)
3 units, **A:** *Aut,* **B:** *Win (J. Levandosky)*

SCCM 237A,B,C. Advanced Numerical Analysis—(Enroll in CS 237A,B,C.)

SCCM 237A. Numerical Linear Algebra
3 units, Aut (Golub)

SCCM 237B. Numerical Solution of Partial Differential Equations I: Linear Multistep Methods
3 units, Win (Fedkiw)

SCCM 237C. Numerical Solution of Partial Differential Equations II
3 units, Win (Staff)

SCCM 238. Parallel Methods in Numerical Analysis—(Enroll in CS 238.)
3 units (Alonso) not given 2002-03

SCCM 315. Linearly Constrained Optimization—(Enroll in MS&E 315.)
3 units, Spr (Murray)

SCCM 336. Advanced Methods in Matrix Computation—(Enroll in CS 336.)
3 units (Staff) not given 2002-03

SCCM 337. Numerical Methods for Initial Boundary Value Problems—(Enroll in CS 337.)
3 units (Staff) not given 2002-03

SCCM 339. Topics in Numerical Analysis—(Enroll in CS 339.)
3 units, Win (Davis)

SCCM 340. SCCM Consulting Workshop
1-3 units, any quarter (Murray)

SCCM 398. Curricular Practical Training—Provides students with on-the-job training under the guidance of experienced, on-site supervisors. Students must register the quarter after their training. Students receive credit and a grade after submitting a concise report detailing work activities, problems worked on, and key results. Prerequisite: written consent of adviser.
1 unit, any quarter (Staff)

SCCM 399. Independent Project
1-15 units, any quarter (Staff)

SCCM 499. Advanced Reading and Research—Prerequisites: majoring in SC/CM; consent of advisor.
1-15 units, any quarter (Staff)

SCCM 530. Applied Mathematics/Scientific Computing Seminar—(Enroll in CS 530.)
1 unit (Staff) not given 2002-03

SCCM 531. Numerical Analysis/Scientific Computing Seminar—(Enroll in CS 531.)
1 unit, Aut, Win, Spr (Golub)