RUTGERS UNIVERSITY
The State University of New Jersey
LIVINGSTON COLLEGE
DEPARTMENT OF COMPUTER SCIENCE

UNDERGRADUATE PROGRAM IN COMPUTER SCIENCE

Paul Ansel, Chairman
Department of Computer Science

MARCH 1970
INTRODUCTION TO THE CURRICULUM

The undergraduate program in computer science is oriented to (i) majors in computer science, (ii) students majoring in other areas (mainly the sciences, mathematics, engineering and business) who are interested in a working knowledge of computer problem solving, and (iii) students (mainly in the humanities) interested in a general introduction to computers, their range of application, and their impact on society.

A major in computer science is expected to acquire the knowledge and skills needed to hold professional positions in areas of design, implementation and operation of computer systems (hardware and software) and of applications software; to teach computer science topics at the high school and college levels; and to prepare him for further graduate study in computer science. Courses that cover prerequisites for graduate study in computer science at Rutgers are available in the undergraduate program.

Because of the rapid rate of growth in the field, a student majoring in computer science must acquire the capability to follow the research and professional literature, and to adapt to changes in methods, languages and systems. Furthermore, he must develop the ability to plan and work independently on substantial computer projects, and to communicate effectively with other people in the course of his work. As the impact of computers on society is becoming more significant from day to day, the student must prepare himself to participate intelligently in managerial and social decisions that involve computers. In view of these requirements, our undergraduate program in computer science emphasizes concepts, theories and general methods which underlie applications of computers and which can be used to guide the design of computer systems. The program also stresses independent study, doing active work on computers with specific languages, and participating in advanced seminars.

A student majoring in computer science is expected to take at least fourteen semester courses in the program (the courses 101 and 102 cannot be used towards this count); eleven of the fourteen are required courses, and the remaining three can be chosen in accordance with the student's specific interests and orientation. Four of the required courses (105, 105, 205, 206) provide the necessary mathematical concepts and methods for work in computer science; students with insufficient previous mathematical preparation are required to take the introductory two-semester course 101, 102 before taking any of these four courses. Three of the required courses (112, 211, 212) are concerned with the fundamentals of computer problem solving and with programming in high level languages (BASIC, FORTRAN, PL/1, SHOBOOL, LISP). Four of the required courses (311, 312, 401, 402) provide the basic concepts and techniques in computer organization, machine-
level programming, and systems software. The remaining three courses—that complete the minimal program for the computer science major—may be chosen from offerings in advanced computer applications (321, 322, 419, 432), social implications (431), computer theory (421), and also from supervised independent study in topics not covered in the formal courses. Students will be strongly urged to devote at least one course to independent study or to a seminar. Our present program (when all the offerings are available) would enable a student to choose up to seven courses in computer science beyond those that are minimally needed for a major. Courses relevant to computer science are also available in the departments of Mathematics (RC, DC), Philosophy (LC), and Industrial Engineering (RC).

A student majoring in computer science would be encouraged to develop an overall study plan (in consultation with his advisor) sometime during his freshman year. The plan would include the student's course requirements for major; courses in computer science beyond the requirements for major, as well as courses in other departments that are relevant to computer science, all chosen so as to enhance the student's professional-educational goals; and courses in other areas in accordance with the student's general interests.

Students majoring in the physical and biological sciences, as well as in mathematics and engineering, will gain a good grasp of computer concepts and a strong competence in the use of computers in their respective fields by taking a sequence of two courses in numerical methods and in computer problem solving (211 followed by 322). Alternatively, students in these fields may gain a knowledge of computers, and programming which is less extensive, but sufficient for many of their needs, by taking the introductory course 112.

Students in the social and behavioral sciences, in business, and in the humanities, will receive a strong preparation in the use of computers in their work by taking a sequence of two courses in nonnumerical methods and computer problem solving (212 followed by 321 or 432). A less demanding alternative would be to take the introductory course 111.

Students interested in a general acquaintance with computers and their uses will find the introductory course 111 sufficient for their needs.

Those interested in studying the broad impact of computers in various aspects of scientific, economic and social
life should participate in the seminar course 431 after taking at least one computer science course (such as 111 or 112).

Even though the introductory mathematical course (105, 106, 205, 206) are specifically designed for computer science majors, their emphasis on applied problems and on constructive processes, and their articulation with courses in computer problem solving, make them well suited for students majoring in certain areas of biology, psychology, anthropology, economics and urban planning.

II. COURSES

Note:

In the descriptions of courses that are given below, the first paragraph (in parenthesis) specifies the year in which the course is offered, and its relationship to other courses that are being initiated or dropped.

The second paragraph (in parenthesis) in each description specifies the type of preparation and orientation that are recommended for students taking the course. Prerequisites are to be taken as strong guidelines that should aid a student to plan his overall program and to decide whether to register in a specific course. Normally, students taking a course should satisfy the course prerequisites. However, special cases will be considered individually by the instructor in charge of the course.

The last part of each description outlines the course content.

INTRODUCTORY APPLIED MATHEMATICS 02:090:101-102

Cr. 4; Eng

(This course is being offered as APPLIED MATHEMATICS--INDEPENDENT STUDY A 02:198:224 in the Spring of 1970; it is to be offered as a college course in 1970-71.)

(Intended for students with insufficient high school mathematical preparation who are interested in pursuing studies towards a computer science major, or in other areas that require an applied mathematics background.)
This course is designed to acquaint students with principles, methods, and procedures for solving problems in elementary applied mathematics. Topics include the number system, decimal numbers, other number bases, basic algebra, sets, exponents and logarithms, linear and nonlinear functions, determinants, matrices, linear programming, numerical methods, trigonometric functions, binomial theorem, and progressions. Additional topics are fundamentals of probability and introduction to statistical methods in experimental science.

BASIC COMPUTER PROGRAMMING

Cr. 1 each term; Droge (course coordinator)

(This course will be given for the last time in 1970-71; it will be dropped thereafter.)

(Intended exclusively for electrical engineering sophomores. It is a course in FORTRAN programming. The material of this course, much strengthened by a general treatment of high level algebraic languages and numerical problem solving, is included in the newly offered course 198:211 (Numerical Problems and Computer Programming). Electrical engineering students who are seriously interested in this subject are advised to take the course 198:211 (instead of 198:103) in 1970-71, even though the course 198:103 will be still available during that time.)

The use of the computer language FORTRAN IV in formulating and solving numerical problems on a computer. Introduction to algorithms, programs, and computers. Debugging and verification of programs. Laboratory sessions will meet weekly.

INTRODUCTORY COMPUTER ORIENTED MATHEMATICS

Cr. 4,4; Beaucage

(This course will be first offered in 1970-71)

(This is a strongly recommended sequence for majors in computer science. A major is required to take this sequence or, alternatively, the calculus sequence and the course in linear algebra offered by the Mathematics Department (RC). This sequence is also recommended for students in other sciences and in urban planning who are interested in mathematical models and computer methods. Prerequisite: satisfactory high school mathematical preparation or 090:101-102.)
The course is designed to present selected topics in calculus and linear algebra that provide useful mathematical foundations for work in computer science; it also attempts to use the computer as an aid for teaching mathematical ideas and methods. The sequence of topics is: numbers and functions; graphs and curves, derivatives; integration; differentiation of vectors; functions of several variables; vector spaces; linear equations and bases; linear mappings; linear maps and variables; techniques of integration; Taylor's formula; complex numbers; series.

Films to be used in the course are (1) the MAA Calculus Films, and (2) Computer Generated Calculus by Schey & Schwartz, Harper and Row. Computer illustrations and experimentation are planned as part of the course. An attempt will be made to integrate some of the work in the second semester of this course with the computer work in the course 198:112 (Introduction to Computer Science).


INTRODUCTION TO COMPUTING 02:198:111

Cr. 4, Fall; Cox

(This course will be first offered in 1970-71. It is a modified and condensed version of the course 090:117-118 (The Computer In Society) which is being offered in 1969-70 but it will be discontinued in 1970-71.)

(Intended for students in the humanities, business, and in the social and behavioral sciences. It is not intended for majors in computer science. No special mathematical background is required.)

The course is designed to acquaint the student with the potential of the computer. Analysis of problems for computer solution. Basic properties of programming languages. Structure of data bases. "Hands on" experience in the use of a specific programming language (BASIC) for solving problems in a variety of application areas on a computer.

INTRODUCTION TO COMPUTER SCIENCE

Cr. 4, Spring; Cox

(This course will be first offered in 1970-71. It is a modified version of the course 090:117-118 (The Computer in Society which is being offered in 1969-70.)

(Required for majors in computer science. Prerequisite: satisfactory high school mathematical preparation or 090: 101-102).

Overview of computer science. History of computation. Number systems used in computers. Computer organization. Arithmetic and decision processes in computers. Levels of computer languages. Algorithms. Analysis of problems for computer solution. Basic features of programming languages. The use of the BASIC language for solving a variety of problems on the computer and for illustrating properties of programming languages. Some of the problems will be mathematical in nature and they will originate from work in the second semester of the course 198:105-106 (Introductory Computer Oriented Mathematics)


INTRODUCTION TO DISCRETE STRUCTURES

Cr. 4, Fall; Rabinowitz

(This course will be first offered in 1970-71)

(Required for majors in computer science. It is also recommended for students in the biological, behavioral and social sciences as well as in urban planning who have a theoretical orientation and are interested in computer methods.
Prerequisite: advanced high school mathematical preparation or 198:105-106.)

The course introduces the student to those fundamental algebraic and logical concepts that are needed for theoretical work in computer science, and it shows applications of these concepts to problems in the field. Topics include set theory, propositional calculus, boolean algebra, and algebraic structures including semigroups and groups. Relationships
between these structures will be presented and applications in the study of computer networks and algorithms will be discussed.


INTRODUCTION TO COMBINATORIAL ANALYSIS AND PROBABILITY THEORY
02:198:206

Cr. 4, Spring; Srinivasan

(This course will be first offered in 1970-71)

(Required for majors in computer science. It is also recommended for students in other sciences and in urban planning who have a theoretical orientation and are interested in computer methods. Prerequisite: 198:205 or equivalent, and 198:105-106 or equivalent.)

The course is oriented to combinatorial problems that are relevant to computer theory and the design of experiments. Arrangements of a finite number of elements in sets will be studies in the context of significant problems in graph theory, boolean algebra, finite state machines, encoding of digital data, and probability theory. Both existence and enumeration problems will be considered. Topics in probability theory will be introduced and they will be applied to problems of simulation.


NUMERICAL PROBLEMS AND COMPUTER PROGRAMMING
02:198:211

Cr. 4, Fall; Fender

(This course will be first offered in 1970-71. It is a modified and strengthened version of the "Computer Programming" part of the course 198:377-378 (Computer Programming and Numerical Methods) which is being offered in 1969-70 but it will be discontinued in 1970-71.)
(Required for majors in computer science. It is also recommended for students majoring in the physical and biological sciences, as well as in mathematics and engineering, who are seriously interested in computer problem solving. Specifically, students who were planning to take the first part of the course 198:377-378 in 1970-71 are now advised to take the present course. Prerequisite: 198:105-106 or equivalent.)

The course concentrates on the study of high level computer languages and their use in the solution of numerical problems. The languages PL/I, and FORTRAN IV will be used throughout the course. Knowledge of them and the skill in using them will strengthen the process. Emphasis will be placed on the analysis and comparative evaluation of the languages. Principles of programming and methods for the accurate and efficient processing of numeric data on computers will be studied. Topics will include representations of numbers and their computer arithmetic; absolute and relative errors; processing random numbers; sort-merge algorithms; subroutines; solution methods for simultaneous equations; root finding methods; methods of numerical evaluation; error propagation; applications to problems in finite mathematics.

NONNUMERICAL PROBLEMS AND COMPUTER PROGRAMMING 02:198:212

Cr. 4, Spring; Paull

(This course will be first offered in 1970-71. It is a modified and strengthened version of the "Computer Programming" part of the course 198:373-374 (Computer Programming and Data Processing) which is being offered in 1969-71 but it will be discontinued in 1970-71.)

(Required for majors in computer science. It is also recommended for students majoring in the social and behavioral sciences, as well as in the humanities and in business, who are seriously interested in computer problem solving. Specifically, students who were planning to take the first part of the course 198:373-374 in 1970-71 are now advised to take the present course. Prerequisite: satisfactory high school mathematical preparation or 090:101-102.)

The course is oriented to the study of high level computer languages and their use in the solution of various nonnumerical problems. The languages PL/I and SNOBOL (and possibly other symbol manipulating languages) will be introduced and used in the course. Basic properties of the languages will
be studied and evaluated via the experience of programming specific problems. Emphasis will be placed on principles of problem solving and programming. Topics will include symbolic representations, strings and lists; editing, text manipulation, concordances, style analysis; file handling; methods of data storage and retrieval; formulation of models and simulation; formula manipulation.

INDEPENDENT STUDY A

Cr. 4,4; Staff

(This course is being offered in the Spring of 1970, and it will continue in 1970-71.)

(Intended for computer science majors who are interested in going deeply into a subject in computer science which is not covered comprehensively in a formal course. Topic and requirements to be determined individually with the supervising instructor.)

Assigned readings, computer work, and discussions in the chosen topic of study. Students will be required to give at least a lecture covering their study.

THEORY OF COMPUTER PROGRAMMING

Cr. 4,4; Staff

(This two-semester course will be given for the last time in 1970-71, with an increase in number of credits from six to eight. It will be replaced in 1971-72 by the course 198:311-312 (Computers and Programming).)

(Intended mainly for students majoring in mathematics and engineering who are strongly interested in computer problem solving, programming techniques, computer organization, and systems software. These students can still take this course in 1970-71. However, those who plan to take the course in 1971-72 are now advised to take first, in 1970-71, a course which is oriented to computer problem solving (preferably 198:211, but 198:212 is also acceptable), and then to take in 1971-72 the course 198:311-312; the latter course will include a much strengthened treatment of computer systems and fundamental programming concepts and techniques, but it will assume familiarity with computer problem solving in some high level language.)
This course is not recommended for computer science majors; these students are advised to take instead, the course 198:311-312 when it will become available in 1971-72. Prerequisite: one year of college mathematics.)

Computer problem solving, algorithms and programming. The use of machine and assembly language. Programming techniques, system and utility programs. Introduction to assemblers and compilers; investigation of their structure. Laboratory sessions in writing, testing, and using programs.

COMPUTERS AND PROGRAMMING 02:198:311-312

Cr. 4,4; Staff

(This course will be first given in 1971-72. It is a modified version of the course 198:301-302 (Theory of Computer Programming) with the treatment of computer organization, and basic programming mechanisms much strengthened.)

(Required for majors in computer science. It is also recommended for students majoring in mathematics and engineering who are strongly interested in programming and in computer structures. Prerequisite: a course in computer problem solving (preferably 198:211, but 198:212 or 198:112 would also be satisfactory) and one year of college mathematics.

Structure of computers, logical design, and machine architecture. Programming in machine language and assembly language. Data structures. Programming and storage techniques. Introduction to systems software. Laboratory work in software design and programming.

DATA PROCESSING METHODS 02:198:321

Cr. 4, Fall; Baxendale

(This course will be first offered in 1970-71. It is a modified and strengthened version of the "Data Processing" part of the course 198:373-374 (Computer Programming and Data Processing) which is being offered in 1969-70 but it will be discontinued in 1970-71.)

(Recommended for majors in computer science, as well as for students in social sciences, humanities and business who are interested in applications of computers in data processing and in information systems. Prerequisite: 198:212.)
Description of a data base and its structure. Concepts of functions, arrays, records, files, trees, lists and list structures. Updating and addition to records. Modes of referencing and accessing records. Hierarchies of storage. Sorting, searching and retrieval of files; the role of programs in the data base, their relocation and allocation of storage.

Business record keeping; case study in inventory control. Management information systems. Inquiring and interactive systems. Automatic indexing and information retrieval.

System simulation and control. Properties of languages in description of simulation models. Design and testing of models; queuing flow in networks, storage and priority systems, feedback systems.


NUMERICAL METHODS

Cr. 4, Spring; Baxendale

(This course will be first offered in 1970-71. It is a modified and strengthened version of the "Numerical Methods" part of the course 198:377-378 (Computer Programming and Numerical Methods) which is being offered in 1969-70 but it will be discontinued in 1970-71.)

(Recommended for majors in computer science, as well as students in physical and biological sciences, mathematics and engineering who are interested in applications of computers to numerical problems. Prerequisite: 198:211.)


LANGUAGE SOFTWARE 02:198:401

Cr. 4, Fall; Staff

(This course will be first offered in 1971-72.)

(Required for majors in computer science. Prerequisite 198:311-312 or 198:301-302, and 198:205 or equivalent).

Introduction to formal properties of programming languages. Schemes of compiling. Structure of compilers and assemblers. Macroprocessors.

OPERATING SYSTEMS SOFTWARE 02:198:402

Cr. 4, Fall; Staff

(This course will be first offered in 1971-72.)

(Required for majors in computer science. Prerequisite 198:311-312 or 198:301-302, and 198:205,206 or equivalent.)


NUMERICAL METHODS IN ORDINARY DIFFERENTIAL EQUATIONS 02:198:419

Cr. 3; Fender

(This course may be offered in 1971-72. It is identical to the present course 198:479 except for a change in course number.)

(Recommended for majors in computer science as well as for students in science and engineering who are interested in advanced applications of computers in "scientific" problems. Prerequisite: a course in ordinary differential equations.)

TOPICS IN COMPUTER THEORY

Cr. 3; Staff

(This course will be first offered in 1971-72)

(Recommended for majors in computer science, especially for those intending to go into graduate work. Prerequisite: 198:311-312 or 198:301-302, and 198:205,206 or equivalent; a desirable preparation would be a course in logic such as the course 730:332 (Intermediate Logic) offered in the Philosophy Dept.)

Introduction to topics in switching and automation theory, the theory of computation and the theory of formal languages.

SEMINAR IN COMPUTERS AND SOCIETY

Cr. 3, Fall; Amarel (coordinator)

(This course will be first offered in 1970-71)

(This senior-level seminar is recommended for majors in computer science and other students who are interested in the spread of the computer culture and its social impact. Prerequisite: at least one computer science course.)

Review of computer applications in the scientific, economic, and social domains. Effects on individuals and organizations; effects on values, education, employment and management. Lecturers, study of reports and papers in selected topics, work on projects and class discussion.

SEMINAR IN NON-NUMERICAL COMPUTER APPLICATIONS

Cr. 3, Spring; Rabinowitz (coordinator)

(This course will be first offered in 1970-71)

(This senior-level seminar is recommended for majors in computer science, as well as for students in social sciences, and humanities, who are interested in advanced applications of computers in non-numerical problems. Prerequisite:...
A course on computer problem solving, preferably 198:212.

Text processing problems. Computer applications in literature, linguistics, history and the arts. Formula manipulation, proof finding and heuristic problem solving. Question answering and dialogue systems. Lectures, study of research reports, work on projects, and class discussion.

INDEPENDENT STUDY B 02:198:495-496

Cr. 4, 4; Staff

(This course is being offered in the Spring of 1970, and it will continue in 1970-71.)

Intended mainly for majors in computer science who are interested in gaining a substantial experience in software design and implementation. Subject and requirements to be determined individually with the supervising instructor.

Design studies and work on computer projects of realistic nature in areas of systems software and in new computer applications.

III. FACULTY

Saul Amarel, Professor and Chairman. B.S. (Technion, Israel); M.S., D. Eng.Sci. (Columbia), Artificial Intelligence, computer linguistics, theory of computational processes, information systems.


Douglas E. Eastwood, Professor and Director of Center for Computer and Information Services. A.B. (Transylvania College), M.S. (Univ. of Kentucky), Ph.D. (Illinois Institute of Technology). Systems design, programming methods and languages. (Not participating in 1969-70).

Fred Fender, Professor of Computer Science and Mathematics. B.S., M.S., Ph.D. (University of Pennsylvania). Numerical analysis in computer solution of differential equations.
Thomas H. Mott, Jr., Professor and Dean of Graduate School of Library Service. A.B. (Rice), Ph.D. (Yale). Switching theory, programming theory, information systems.

Marvin C. Paul, Professor B.S. (Clarkson). Theory of programming languages, translators, switching theory.

Irving N. Rabinowitz. Professor and Director of Research Center for Computer and Information Services. B.S. (City College, N.Y.), M.A., Ph.D. (Princeton). Programming languages, language processors, software design.

Stanley Baxendale. Associate Professor and Vice-Chairman. B.S. (Leeds), Computer graphics, automatic indexing.

Donald R. King, Associate Professor and Associate Director of Research, Center for Computer and Information Services. A.B., M.S. (Rutgers). Non-numerical data processing, information retrieval.

Chitoor V. Srinivasan, Research Associate Professor. B.Sc., D.M.I.T. (Madras), M.S., D. Eng. Sci. (Columbia). Description languages, data structures, computer organization, coding theory.

David R. Beaucage, Assistant Professor. A.B., M.S. (Rutgers), Ph.D. (New York at Stony Brook). Non-numerical methods, computers in mathematical research.


John W. Philpot, Assistant Professor and Assistant Director, Center for Computer and Information Services. B.A.E. (New York U.); M.S., Ph.D. (Virginia Polytechnic). Statistical Methods.

Lauchland A. Henry, Lecturer, B.S., M.S., D.Sc. (Columbia) Numerical analysis. (Not participating 1969-70)


IV. DISCUSSIONS AND GENERAL RECOMMENDATIONS

The modification of the current undergraduate curriculum in computer science has been guided by the need to create a sound and well-structured four-year program for majors, and to integrate it with other programs for non-majors—some existing and some new. Such an integration is absolutely necessary in view of the present size of our active faculty and the demands of our graduate program.

In the changing of the undergraduate curriculum, we are creating a discontinuity whose effect we have attempted to minimize by distributing over a period of two years the introduction of new courses and the retirement of old ones.

Thus, students will face few unexpected changes in their preregistration for 1970-71. However, it is important that they become aware as soon as possible of the few changes that are expected in 1970-71, and also of the changes that are expected in the following year since these changes may have an effect on some of their present choices of courses.

Comments on the Old Program

198:103 (Basic Computer Programming). The course will be discontinued in 1971-72. In 1970-71, E.E. sophomores have the option of taking 198:103 or the more comprehensive new course 198:211 (Numerical Problems and Computer programming). In 1971-72 and thereafter, E.E. students interested in FORTRAN programming will have a single option in the Computer Science Dept., namely, 198:211; other alternatives should be developed outside our department, possibly as part of the educational program of the C.C.I.S.

090:117-118 (The Computer in Society) This course sequence will be discontinued in 1970-71, and it will be replaced by 198:111(Introduction to Computing) and
198:112 (Introduction to Computer Science). In 1970-71 freshmen interested in an introductory computer course are advised to choose 111 or 112 according to their mathematical background and orientation.

Our experience with "The Computer in Society" course, and the experience in other universities with similar courses (Dartmouth, Wisconsin), indicates that such a course is most appropriate for students at about the senior year with some familiarity in the use of computers and with more knowledge and intellectual maturity, than freshmen. First-year students are very interested in acquiring specific knowledge and skills in the use of computers, and for many of them the task of mastering the mental discipline and the unfamiliar conventions needed to program a computer takes precedence over any abstract thinking about computers. Backgrounds vary considerably in the freshman class, and it is necessary to present an introductory computer course in different ways for students of different orientations. These are the reasons for our two new courses at the freshman level (198:111,112) and the new Seminar in Computers and Society (198:431) at the senior level.

One of our important objectives is to constantly improve our introductory courses by using computers as an integral part of the educational process. At present, students in the course 198:117-118 are using remote terminals and the BASIC language for computing on a time sharing mode. The development of a flexible software system that would allow convenient communication between a student sitting at his terminal and a data base of problems, solutions, and programs that is accessible to the instructor from his terminal is an important next step in the improvement of the course. Further developments are possible with the computer assuming an increasingly central role in the instructional process. An interesting possibility is the integration of instruction in parts of introductory mathematics and in computer problem solving. We plan to explore this possibility in 1970-71 with our courses 198:106 and 198:112. Progress in this general area would facilitate the familiarization of an increasing number of freshmen (over a wide variety of previous educational experiences) with basic mathematical concepts, with methods of problem solving, and with computer programming.
198:301-302 (Theory of Computer Programming) In 1970-71 this course sequence will not change appreciably, except for an increase in two credits that reflects more realistically the work involved in the sequence. The course will change in 1971-72 to 198:311-312 (Computers and Programming) and it will become a key part of the program for majors in computer science. Non-majors who are interested in taking the course in 1971-72 are advised to take in 1970-71 the course 198:211 (or 198:212) which is needed as a prerequisite for 198:311-312.

198:373-374 (Computer Programming and Data Processing) This course sequence will be discontinued in 1970-71. Students interested in the course are advised to take the sequence of courses 198:212 (Nonnumerical Problems and Computer Programming), followed by 198:321. This sequence is a much strengthened version of 198:373-374. The earliest time at which the first course in the new sequence can be taken is the Spring of 1970-71.

198:377-378 (Computer Programming and Numerical Methods) This course sequence will be discontinued in 1970-71. Students interested in the course are advised to take the sequence of courses 198:211 (Numerical Problems and Computer Programming) followed by 198:322 (Numerical Methods). This sequence is a much strengthened version of 198:377-378. Students can already take a complete new sequence starting in the Fall of 1970-71.

198:417 (Computer Programming and Numerical Methods for Research) This course will be discontinued in 1970-71. Undergraduate students interested in the course are advised to take the course 198:211 (Numerical Problems and Computer Programming), or the sequence of courses 198:211 followed by 198:322 (Numerical Methods). Graduate students interested in the course are advised to take the graduate course CS 510 (Numerical Analysis).

198:479 (Numerical Methods in Ordinary Differential Equations) This course will remain in the course list of the department, with its number changing to 198:419. The course is not offered in 1969-70 and it will not be offered in 1970-71; it may be offered in 1971-72.
SCHEDULES OF COMPUTER SCIENCE MAJORS:

Let us consider two examples of course schedules (only courses offered in our program are shown) for majors in computer science. In the first example, the student has satisfactory mathematical background upon entering the program; in the second example the student's mathematical background is insufficient.

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<th>Year</th>
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<th>Second Example</th>
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It is clear that both the student who is well prepared mathematically and the student with an insufficient mathematical background can complete the requirements for the major in four years (even though in the latter case, the first year is devoted to the introductory sequence in applied mathematics (101,102). Both students can accommodate in their schedules the fourteen semester courses required for the major, and they could also add more computer science courses in their 3rd and 4th year if they so wished.