

University Senate of Michigan Technological University

Proposal 18-94

Ph.D Program in Computational Science & Engineering Within the Ph.D in Engineering

This is a proposal to establish a non-departmental Ph.D. program in Computational Science and Engineering as a new program within the Ph.D. in Engineering (Faculty Senate Proposal 3-84). The Ph.D. in Engineering program is designed to provide a vehicle to serve important areas of research and education that cannot be adequately treated by traditional departments. The proposed Ph.D. program in Computational Science and Engineering qualifies as such an area because it combines mathematics, computer science, the physical sciences, environmental engineering, and other engineering disciplines to investigate and develop solutions to important computationally intensive problems in these areas. Effective progress toward solutions to problems such as the "grand challenges" of global climate modeling, groundwater transport, genome sequencing, and computational chemistry, necessitates an approach which integrates interdisciplinary collaboration and fundamental computer science. The proposed Ph.D. program will join faculty and students in an interdisciplinary program of high visibility to contribute to solutions for a broad range of scientifically interesting and economically significant problems. The program will be unique in its ability to simultaneously provide researchers who understand the scientific and engineering problems required for sustainable growth and researchers who understand the computational theories and methods needed to implement solutions to these problems. While this program is being developed with emphasis on its interdisciplinary nature, it is critical to the success of the program that computer science research be nurtured. As stated in a special CS&E section of the October 1993 issue of *Computer* (page 8), the ". . . interaction between the applications, algorithms, architectures, and underlying system software characterizes computational science and engineering (CS&E)." The dependence upon computer science foundations for algorithms, architectures, and underlying system software means that to establish a quality CS&E program a solid research base in computer science is needed. In fact, the inter-dependence of the CS department and the proposed CS&E program should lead to a more research-active CS department and a fundamentally strong CS&E program. Thus, in addition to supporting faculty and students in interdisciplinary computational science and engineering research this program will also support faculty and students in computer science research.

The governance and operation of this Ph.D. program will be in accordance with the Proposed Degree Offering for the Doctor of Philosophy in Engineering (June 14, 1984). That program gave general responsibility for non-departmental programs to the University Non-Departmental Studies Committee and it gave the responsibility for the management of individual programs to the participating faculty. This proposal presents the initial membership of the Computational Science and Engineering Faculty Committee that will manage the new Ph.D. program; it outlines the structure and responsibilities of the Ph.D. student's Advisory Committee; and it describes the general academic requirements of the Ph.D. program.

Need and Motivation for the CS&E Program

A major goal of Michigan Technological University as stated in its Five Year Plan is to increase the number of graduate students and especially the number of Ph.D. students. This new program could thus clearly help the University reach this goal. Of course, any new Ph.D. program must satisfy needs associated with thrust areas of the program itself, and in this respect the CS&E program is most timely.

Every discipline in science and engineering is using computers to an extent unimagined just a few years ago, and in many cases sub-areas of these disciplines have been and are being created and defined by computers. A major problem in the continuing development of these (sub)areas is finding scientists and engineers with the needed expertise in an application area and in computation. This program gives MTU an opportunity to be at the fore of the development of such programs.

Computational Science and Engineering Faculty Committee

Initial membership:

Donald Beck, Professor of Physics
Barbara Bertram, Assistant Professor of Mathematical Sciences
Richard Brown, Professor of Chemistry
Gerard Caneba, Assistant Professor of Chemical Engineering
Steven Carr, Assistant Professor of Computer Science
Jeffrey Coleman, Assistant Professor of Electrical Engineering
James Friendeway, Assistant Professor of Business and Engineering Administration
Richard Honrath, Assistant Professor of Civil and Environmental Engineering
Xiaoqiu Huang, Assistant Professor of Computer Science
Jacqueline Huntoon, Assistant Professor of Geological Engineering, Geology and Geophysics
John Jaszczak, Assistant Professor of Physics
Donald Kreher, Professor of Mathematical Sciences
John Lowther, Associate Professor of Computer Science
Alex Mayer, Assistant Professor of Geological Engineering, Geology and Geophysics
Austin Melton, Professor and Head of Computer Science
Donna Michalek, Assistant Professor of Mechanical Engineering and Engineering Mechanics
Linda Ott, Associate Professor of Computer Science
Ravindra Pandey, Assistant Professor of Physics
David Poplawski, Associate Professor of Computer Science
Robert Reynolds, Assistant Professor of Computer Science
William Rose, Professor and Head of Geological Engineering, Geology and Geophysics
Maximilian Seel, Dean of the College of Sciences and Arts and Professor of Physics
Steven Seidel, Associate Professor of Computer Science
Philip Sweany, Assistant Professor of Computer Science
Song-Lin (Jason) Yang, Assistant Professor of Mechanical Engineering and Engineering Mechanics

Chairperson: Austin Melton will be the initial Chairperson for a 4-year term beginning on June 1, 1994. Subsequently, one Faculty Committee member will be appointed Chairperson; he/she will be appointed for a 4-year term by the Dean of the Graduate College from a list provided by the Faculty Committee. The responsibilities of the Chairperson will be:

- Overall responsibility for the quality and management of the CS&E Ph.D. program.
- Decide membership of the Faculty Committee, with the concurrence of the Dean of the Graduate College and the Faculty Committee.
- Approve appointments to Advisory Committees.

Director of Admissions and Early Advising: Elected by the Faculty Committee for an initial term of 2 years and subsequently for a term of 4 years. The Director's primary responsibility will be to make recommendations to the Faculty Committee regarding student admissions and to advise new students in the program. This person will function as the Chairperson in case of his/her absence.

Monetary Concerns

There will be no start-up costs for this program; the faculty and the equipment are already here. There is, moreover, the potential for an increase in external funding. As the computational scientists and engineers

and the computer scientists begin to work together, possibilities for interdisciplinary research and increased external funding will become evident.

Admission Requirements

Students with an M.S. degree in the mathematical sciences, computer science, the physical sciences, or engineering will be considered for admission to the program.

Advisory Committee

Each student will have an Advisor who is a member of the Faculty Committee and who is approved by the Chairperson. The Advisor will have the primary responsibility for supervising the student's research project and for directing the student's academic and professional development.

Each student will have an Advisory Committee consisting of the student's Advisor and at least four additional members. Two of the four may be from the same department as the Advisor. At least two must be from outside that department. One of the committee members must be an engineer. It is recommended that one of the four be from outside of MTU. The Advisory Committee members from MTU must be members of the Graduate Faculty. The Advisory Committee members will be nominated by the Advisor in consultation with the student and subject to the approval of the Chairperson.

The interdisciplinary nature of this program makes it essential that the Advisory Committee actively participate in the research project. The Advisory Committee members from MTU must be appointed early in the student's research program. They will meet at least quarterly with the Advisor and the student to review progress. At each meeting the student will present a brief written or oral progress report and will discuss progress with the committee members. It is expected that the student will meet more frequently with the Advisor and certain of the committee members in the pursuit of the research project.

Comprehensive Examination

Each student must pass the Comprehensive Examination. This examination is given in two parts: a Computational part and a Specialty part. The Computational part must be taken first or during the same testing period as the Specialty part, and the Specialty part must be taken by the end of the second year. The tests will be given (when requested) in the fall and spring quarters of each year. Each student who intends to sit for the either part of the Comprehensive Examination must declare that intention by the end of the second week of classes in the term the exam is to be taken. Each type of exam will be administered by a committee of four faculty members who will decide whether or not each student passes; a student will pass if at least three committee members vote pass. (When more than one Computational or more than one Specialty exam is being given, it may be necessary to have different committees of four administer the different exams.) Passing the Comprehensive Examination elevates the student to the status of Doctoral Candidate. After each part of the exam or after both parts if both parts are taken during one testing period, the student and the student's Advisory Committee will meet to review orally the exam.

Computational: If the student plans to work in an applications area, the Computational Examination will cover the student's general expertise in computational principles. If the student plans to work in a standard computer science area, the Computational Examination will cover the student's general expertise in advanced computer science topics. The exam may be retaken once only with the approval of the Chairperson and three members of the student's Advisory Committee.

Specialty: The Specialty Examination is an in-depth examination in the area of research that the student plans to pursue. The exam may be retaken once only with the approval of the Chairperson and three members of the student's Advisory Committee.

Non-MTU Advisory Committee Member: If a member of the Advisory Committee is not from MTU, he/she will not be involved in the Comprehensive Examination; his/her purpose is to strengthen the actual research activities of the student's work.

Degree Requirements

The major thrust of the CS&E program is the integration of state-of-the-art computation and application areas. Thus, every student in the program will be expected -- either in his/her past course work and/or experience or in his/her Ph.D. work -- to be involved with state-of-the-art computation and an application area in engineering or the sciences. Each student must take twenty-four (24) hours of course work. All the hours must be at the 400 level or above, and eighteen (18) of the twenty-four (24) hours must be at the 500 level or above.

Teaching Portfolio (optional)

Since a major objective of this Ph.D. program is to prepare students for academic careers, provisions will be made to assist students in preparation for careers in academia. Thus, students in the Computational Science and Engineering (CS&E) Ph.D. program will be strongly encouraged to prepare a *teaching portfolio* during their studies. To complete a teaching portfolio a student would be expected to teach at a level and in a subject area selected by mutual agreement with the Chairperson and the student's Advisor. In addition to teaching experience, a student should prepare a portfolio of written materials which would include at a minimum: a personal teaching philosophy statement and course materials generated while teaching.

To enable students to effectively prepare for academic careers and to assist in preparation of such a teaching portfolio, the Faculty Committee is committed to maintenance of a teaching working group, open to all CS&E Ph.D. students. The charter of this group is to investigate and evaluate teaching methods appropriate to the field of CS&E.

Dissertation Proposal

This is a written and oral description of the research plan made by the student to his/her Advisory Committee. The proposal should be made within one year of achieving Doctoral Candidacy. The student's advisory committee must unanimously agree that the research plan is acceptable. The Chairperson will be notified of the outcome of the Dissertation Proposal. The oral proposal is open to the University community.

Research Review

At least three months prior to the dissertation defense, the student will present his/her research findings to his/her Advisory Committee for its approval. While the presentation will be oral, a written outline of significant results should be provided for committee members. The purpose of this review is to evaluate the contribution of the work as well as to assist in maintaining a focus for the dissertation. The student's Advisory Committee must agree that the research is acceptable and that the student's progress is satisfactory. The student will be allowed to repeat the research review until such approval is given.

Dissertation Defense

The research conducted by the student will be presented to the Advisory Committee as a written dissertation. An oral presentation of that dissertation will be made following the completion of the written work. The dissertation is acceptable if the Advisor and at least three of the remaining four members of the Advisory Committee concur on its acceptance. The oral defense is open to the University community.

Adopted by Senate: May 4, 1994

Approved by President: June 12, 1994