Department of Computational Science

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(585) 395-2021

Associate Professor and Chair: Robert E. Tuzun, PhD, University of Illinois/Urbana-Champaign; Empire Innovation Professor: Osman Yasar, PhD, University of Wisconsin/Madison; Associate Professor: Leigh J. Little, PhD, Arizona State University; Assistant Professor: Wensheng Shen, PhD, University of Kentucky, and PhD, Tennessee Technological University.

Along with traditional experimental and theoretical methodologies, advanced work in all areas of science and engineering has come to rely critically on computation. Computer modeling combined with visualization represents a new paradigm for scientific exploration and technological research and development. It permits a new approach to problems that were previously inaccessible. The goal of the Computational Science Program is to enable students to perform computational modeling in problems of technological and societal relevance. To this end, graduate students learn a core set of skills in mathematics, computer programming, visualization and simulation/modeling, and practice these skills on high performance computers located within the department and at nationwide supercomputing facilities. Graduate students supplement these skills with independent study, culminating in a master's thesis.

Nearly all areas of science and engineering now use computers for modeling and problem solving. The aerospace industry uses this approach to design safe and economical aircraft. The automobile industry uses similar techniques to design better engines and safe vehicles. Computational technology is used in medical and pharmaceutical industries to develop new drugs, interpret and construct visual images of medical data such as MRI, and to assist in medical procedures. Meteorologists use computational techniques to predict the weather and long-term climate changes. Ecologists and biologists use computer models to study the environment, population dynamics and the influence of pollutants on the body, the air and the ocean. Economists use computers to predict future behavior of many financial systems, including the stock market. Computer modeling enables the study and performance testing of systems before they are put into production. This approach has saved billions of dollars and years of development time.

The program's flexibility allows students to apply math, computer and computational skills to an area of their choice. Scholarships and/or graduate assistantships may be available for highly qualified candidates. Graduates are well prepared for future employment in industry, research and academia. The incredible growth in the information-technology sector promises many exciting opportunities for those with computational expertise. The department has received equipment support from Sun, Intel, and Silicon Graphics and works closely with local industry. Our recent graduates have found employment in industrial, governmental, and educational settings such as Lockheed Martin, Boeing, Google, Paychex, General Electric, Ricoh, the United States Navy, and the Rochester City School District.

Graduate Degree in Computational Science

The Master of Science (MS) in Computational Science requires 30 graduate credits, including 18 credits of required courses and 12 credits of electives. The program is appropriate for students with a BS in many fields, including computer science, math, physics, chemistry, biology, earth sciences, engineering, business and visual arts.

(A) Required Courses

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<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CPS 533</td>
<td>Scientific Visualization</td>
<td>3</td>
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<tr>
<td>CPS 602</td>
<td>Advanced Software Tools</td>
<td>3</td>
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<td>CPS 604</td>
<td>Computational Methods in the Physical Sciences</td>
<td>3</td>
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<tr>
<td>CPS 644</td>
<td>Supercomputing and Applications</td>
<td>3</td>
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(B) **Required Research Experience**

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<tr>
<th>Course</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>CPS 699*</td>
<td>Independent Study</td>
<td>3</td>
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<tr>
<td>CPS 710</td>
<td>Thesis</td>
<td>3</td>
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(C) **Elective Courses (chosen through advisement)**

- Two 500-level or higher graduate courses: 6 credits
- Two 600-level or higher graduate courses: 6 credits

**Total credits (including electives): 30**

**Recommended Electives:**

- CPS 504  Applied and Computational Mathematics 3 credits
- CPS 505  Applied and Computational Mathematics II 3 credits
- CPS 517  Introduction to Computational Chemistry 3 credits
- CPS 521  Introduction to Computational Physics 3 credits
- CPS 541  Introduction to Computational Finance 3 credits
- CPS 555  Introduction to Computational Fluid Dynamics 3 credits
- CPS 632  Deterministic Dynamical Systems 3 credits
- CPS 633  Stochastic Dynamical Systems 3 credits
- CPS 699* Independent Study 3 credits
- CSC 501  Theory of Programming Languages 3 credits
- CSC 506  Algorithms and Data Structures 3 credits
- CSC 511  Computer Architecture 3 credits
- CSC 512  Operating Systems 3 credits
- CSC 519  Computer Networks 3 credits
- CSC 521  Computer and Network Security 3 credits
- CSC 522  Relational Database Design 3 credits
- CSC 527  Software Engineering 3 credits
- CSC 529  Object-oriented Programming 3 credits
- CSC 534  Artificial Intelligence 3 credits
- CSC 542  Electronic Commerce Technology 3 credits
- CSC 544  Introduction to Parallel Computing 3 credits
- CSC 583  Theory of Computation 3 credits
- MTH 521  Number Theory 3 credits
- MTH 542  Statistical Methods II 3 credits
- MTH 546  Probability and Statistics II 3 credits
- MTH 556  Advanced Differential Equations 3 credits
- MTH 561  Deterministic Mathematical Models 3 credits
- MTH 562  Stochastic Mathematical Models 3 credits
- MTH 571  Numerical Analysis 3 credits
- MTH 581  Discrete Mathematics II 3 credits
- MTH 621  Algebra 3 credits
- MTH 628  Applications of Algebra 3 credits
- MTH 641  Mathematical Statistics 3 credits
- MTH 651  Real Analysis 3 credits
- MTH 659  Topics in Analysis 3 credits
- MTH 669  Topics in Applicable Mathematics and Statistics 3 credits

**3 credits of CPS 699 are required, but up to nine credits total may be taken.**

**Please consult with faculty advisor about availability of additional electives.**
Graduate Degree in Computational Science

Admission into the MS in Computational Science Program is competitive and is based upon previous academic performance, letters of recommendation and work experience. International students must provide documentation of English language proficiency for all non-native speakers of English. The College accepts the Test of English as a Foreign Language (TOEFL) and IELTS. For the TOEFL, a minimum score of 550 on the paper-based version, or a 213 on the computerized version, or a minimum score of 79-80 on the iBT version is required for consideration for admission. For the IELTS, a minimum score of 6.5 is required. Applicants must have a 3.0 undergraduate GPA; however, conditional admission may be granted in unusual cases. Application materials are to be submitted to the Office of Graduate Admission and must include a statement of interest, official transcripts, TOEFL score (if applicable) and two letters of recommendation. A Plan of Study, developed between each student and his or her advisor, must be submitted before the end of the first semester of study.

Computational Science Courses

CPS 504 Applied and Computational Mathematics (A). A survey of scientific computing methods, emphasizing programming methods, interpretation of numerical results, and checks for numerical sensibility and self-consistency. Organized into several modules, including: (1) representation of floating point data, truncation and rounding error, and basic considerations for accurate numerical computation; (2) iterative numerical methods; (3) numerical differentiation and integration; (4) numerical interpolation; (5) random number generation; (6) the Fast Fourier Transform; and (7) numerical solution of ordinary differential equations. Extensive programming required. 3 Cr. Fall.

CPS 505 Applied and Computational Mathematics II (A). A continuation of Applied and Computational Mathematics I. Topics include: iterative methods in numerical linear algebra, least squares methods, the Fast Fourier Transform, special functions and their computation, numerical solution of ordinary equations. Extensive programming required. 3 Cr. Spring.

CPS 517 Introduction to Computational Chemistry (A). Cross-listed as CHM 517. An introduction to classical and quantum simulation methods as applied to chemistry-related problems and computational chemistry software packages. Covers the topics in three parts. Part I: introductory material, potential energy surfaces, vibrational and electronic properties of molecules, and capabilities/limitations of computational chemistry. Part II: classical molecular simulation methods, molecular dynamics, molecular dynamics, Monte Carlo calculations, normal coordinate analysis, computer “measurement” of materials properties. Part III: Schrodinger equation, common electronic structure methods, basis sets, geometric optimization and molecular properties. 3 Cr.

CPS 521 Introduction to Computational Physics (A). Prerequisites: PHS 202, CPS 304 and MTH 203. An introduction to computational methods commonly used in physics applications, including three of the most famous equations in physics (Wave, Laplace and diffusion), as well as classical mechanics. Includes the classical equations of motion, detailed solution of the two-body l/r problem, planetary and astrophysical simulation methods and analysis of simulation data, wave motion and normal coordinate analysis, electromagnetic field and Laplace’s equation, molecular simulation (N-body methods, liquid simulation, liquid structure, specification of initial conditions, constant temperature and pressure simulations, Langevin and Brownian dynamics, and correlation functions), diffusion and percolation. 3 Cr. Fall.

CPS 533 Scientific Visualization (A). Prerequisites: MTH 424 and either CSC 203 or CPS 202. Examination of scientific visualization as a critical portion of the analysis and interpretation of numerical simulations, and an introduction to a wide variety of methods used for scientific visualization. Topics include: basic 2 and 3 dimensional graph types, visualization of 3D data, interpretation of simulation results, grid generation and visualization, problem solution via graphical techniques, image processing, rendering and animation. Extensive programming in MATLAB required. 3 Cr. Spring.

CPS 541 Introduction to Computational Finance (A). Prerequisites: CPS 201, MTH 201 and ACC 281. Examines computational finance, a rapidly expanding discipline that merges the study and prediction of the behavior of investments in financial markets (such as the options and derivatives markets) with high-performance computing. Explores some of the fundamental principles for prediction in the options and derivatives markets in addition to recent adaptations and modifications.
to these principles. Topics include: definitions and terminology, portfolio optimization, risk/asset management, the Black-Scholes model, and the Capital Asset Pricing models. 3 Cr. Fall.

CPS 555 Introduction to Computational Fluid Dynamics (A). Prerequisites: CPS 101, CSC 120 and MTH 203. A concise introduction to the analytical and computational techniques required for the investigation of fluid flow through computational means. Topics include: derivation of fundamental equations, dimensional analysis and the Pi theorem; stability of numerical methods; the CFL condition; first, second, and higher order numerical methods; shooting methods; wave equations; parabolic equations; boundary layers; cavity flows; and grid generation. 3 Cr.

CPS 561 Introduction to Computational Methods in Biology (A). Prerequisites: CPS 201, BIO 111. An introductory survey course on the applications of computer modeling and simulation to biological problems. Topics include molecular simulation for determination and dynamical properties of biological molecules and bioinformatics. Also covered is the use of the Biology Workbench, MATLAB, AMBER and other packages for biological simulations. 3 Cr. Spring.

CPS 602 Advanced Software Tools (A). Prerequisite: CPS 202 and CPS 303. High level tools for parallel computing, mainly the Portable, Extensible Toolkit for Scientific Computing (PETSc). Examples and programming assignments draw heavily from partial differential equations and eigenvalue problems from the applied physical sciences. In addition, employs other high level tools such as finite element simulators. Topics include: numerical solution of partial differential equations and eigenvalue problems, evaluating the parallel performance of tools, iterative methods for the solutions of linear equations, and finite element analysis of problems in the physical sciences. Extensive programming required. 3 Cr.

CPS 604 Computational Methods in Physical Sciences (A). Prerequisite: CPS 504. A one-semester survey of methods for the computer solution of ordinary and partial differential equations (ODE’s and PDE’s) that commonly arise in scientific applications, and for analyzing results. Part I: numerical linear algebra. Part II: finite difference methods for ODE’s and PDE’s, including truncation error and consistency: one-stage, multistage, and multistep methods, initial value and boundary value problems; and systems of equations. Part III: finite element methods for ODE’s and PDE’s, including choice of basis and weighting functions (collocation, subdomain and Galerkin methods); general procedures for elementwise integration; treatment of boundary conditions; and finite element methods in two and three dimensions. Requires extensive programming. 3 Cr.

CPS 632 Deterministic Dynamical Systems (A). Prerequisites: either CPS 404 or CPS 504 and MTH 424. A one-semester survey of methods for the modeling and analysis of deterministic dynamical systems found in chemical, biology, fluid dynamics and other applications. Part I: formulations of classical mechanics, conservation laws, and families of solutions in some model systems. Part II: detailed discussion of simulation methods in chemistry, ecology, biology, fluid dynamics and other fields. Requires extensive programming. 3 Cr.

CPS 633 Stochastic Dynamical Systems (A). Prerequisites: either CPS 404 or CPS 504 and MTH 424. A one-semester survey of methods for computer simulations and other calculations involving some level of random (stochastic) behavior. Covers modeling and analysis of stochastic dynamical systems in science, engineering and business applications. Topics include: generation and statistical properties of discrete and continuous random number distributions; numerical integration; solution of stochastic differential equations commonly arising in scientific applications; Monte Carlo methods; discrete event simulation, including general principles, queuing and inventory simulations, and the use of simulation software; and analysis of simulation data. Requires extensive programming. 3 Cr.

CPS 644 Supercomputing and Applications (A). Prerequisite: CPS 303. An extensive introduction to parallel computing, mostly in the context of scientific and mathematical applications. Topics include historical background and general capabilities of parallel computing; modern parallel architectures and interconnection networks; the MPI (Message Passing Interface) standard and parallel programming methods; issues in parallel programming such as deadlock, safety and fairness; parallel algorithms from numerical linear algebra, sorting and graph theory applications; porting of codes from serial to parallel architectures, and between different parallel architectures; performance issues and benchmarking; and parallel debuggers. Extensive programming required, using parallel computing environments both on campus and at national supercomputing facilities. 3 Cr.

CPS 698 Graduate Seminar (A). Provides a forum for the review and discussion of new discoveries and ideas in computational science. Explores information of topical interest obtained from recent issues of computational science journals. Research carried out by students and/or faculty may also be described and discussed. 1 Cr.

CPS 699 Independent Study (A). Arranged in
consultation with the instructor-sponsor prior to registration. 1-6 Cr.

**CPS 700 Project Paper (A).** Targets development of skills for independent research or problem solving in the realm of computational science. Entails a computational project mutually agreed upon between the student and instructor with regular meetings for guidance and feedback. Also requires a written report and 20–30 minute presentation. 3 Cr.

**CPS 710 Thesis (A).** Mentored individual investigation for a substantial research project in computational science, to culminate in a master’s thesis and oral defense. 3 Cr.

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**DEPARTMENT OF COUNSELOR EDUCATION**

184 Albert W. Brown Building
(585) 395-2258

*Chairperson and Professor:* Susan Rachael Seem, PhD, LMHC, NCC, ACS, Pennsylvania State University; *Associate Professors:* Patricia Goodspeed Grant, EdD, LMHC, NCC, University of Rochester; Thomas J. Hernandez, EdD, LMHC, University of Rochester; *Assistant Professors:* Robert Dobmeier, PhD, LMHC, CRC, University of Buffalo; Kathleen “Kitty” Fallon, PhD, NCC, IMH, University of Florida; Summer Reiner, PhD, LMHC, NCC, University of Connecticut.

**Mission Statement**
The mission of the Department of Counselor Education is to educate excellent practitioners of counseling who choose an emphasis for special preparation in college, mental health or school settings. In doing so, the department enhances the quality of life in society by promoting the development of professional counselors who advance the counseling profession and promote respect for human dignity and diversity. Counselors are individuals with an advanced degree (MSEd, MS, CAS) who apply mental health, psychological or human development principles that address wellness, personal growth, career development and pathology. The MSEd program in Counseling (College Counselor and School Counselor emphases) and the MS program in Mental Health Counseling, are approved by the Council for the Accreditation of Counseling and Related Educational Programs (CACREP). The department also offers a Certificate of Advanced Study (CAS) leading to permanent New York State School Counselor Certification.

**Philosophy and Purposes**
This program seeks to prepare excellent counselors who choose an emphasis for special preparation in college, mental health or school settings. Such counselors possess knowledge of human behavior and social systems, counseling and communication skills, self-awareness, and respect for human dignity and diversity. As a result, they are able to integrate this knowledge, skills and attitudes with their personhood. This combined emphasis on skill development, theory and utilization of self produces counselors who function effectively in a variety of mental health settings and who have a positive impact on the individuals, agencies, institutions and/or communities in which they work.

The philosophy of the program emphasizes the personhood of the counselor and utilization of self as the most important instruments in effecting therapeutic and systemic change. Thus, classroom instruction combines experiential (self) and didactic learning to create opportunities for students to acquire and demonstrate theoretical knowledge, practical skills, and understanding and utilization of self necessary to be effective counselors. Further, the program exposes students to multiple theoretical orientations. Finally, students are expected to learn how to learn by acquiring the skills necessary to continue personal growth and professional development while in the program and after the completion of their formal education.

**Program Objectives**
Students realize the above statement of purposes and philosophical beliefs through successful achievement of the following objectives. At the completion of the MS in Education-Counseling