COMPUTATIONAL & APPLIED MATHEMATICS PATH TO DEGREE

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The CAM requirements appear on the CAM web site:

`http://www.ices.utexas.edu/cam/`

Computational Science & Engineering

Computational science and engineering (CSE) is an exciting and emerging field of rigorous interdisciplinary scientific study. The use of mathematical modeling is growing rapidly and used

- to understand the dynamics of complex systems, and
- to make predictions about their behavior.

Traditionally, the pillars of science are theory and experiment. Today, CSE is becoming the third pillar, providing a link between the first two pillars through high performance computing and simulation.

Overview of CAM

Like CSE, CAM is interdisciplinary. To analyze, model, and simulate a system, researchers must develop a broad and deep understanding of the three CAM Concentration Areas:

Area A. Applicable mathematics;

Area B. Numerical analysis and scientific computation;

Area C. Mathematical modeling of a natural, engineered, social, or other system.

A disciplinary view misses the surprisingly complex ways these interact.

Each student must demonstrate breadth and proficiency in each of the three concentration areas. Research for CAM dissertations must demonstrate an interdisciplinary theme and draw on knowledge from the three CAM concentration areas.

CAM Masters Degree

Options. Fulfill one of the following

1. Thesis and 24 credit hours of coursework plus 6 credit hours of thesis preparation (30 credit hours total);
2. Report and 30 credit hours of coursework plus 3 credit hours of report preparation (33 credit hours total);
3. 36 credit hours of coursework.

This is a two-year program of study. (A full graduate load is 3 courses or 9 credit hours per semester).

Requirements.

- Course selection must be approved by the Graduate Adviser.
- At least 24 hours taken for a letter-grade in the 3 CAM Areas.
- At least 6 hours in each CAM Area.
- All Graduate School requirements must be fulfilled.
- Overall grade point average 3.0 (B) or better.
- Reports and Theses require an adviser from the CAM GSC and a reader to approve the document.

CAM Ph.D. Degree

Two starting points (the two degree options):

1. Computational and Applied Mathematics (CAM) Option
   [more math, less applications background]
2. Computational Engineering and Sciences (CES) Option
   [more applications, less math background]

Upon entering the program, each student must elect an option.

The key question is: Can you handle graduate level mathematics?

The single ending point (a single degree):

Doctor of Philosophy in Computational and Applied Mathematics

Required Grade Point Average

CAM Concentration Area work

- Cumulative GPA 3.25 (B/B+) or better
- One area GPA of 3.5 (B+/A-) or better

Remark: Texas uses the following grade scale.

A	4.00 grade points	C	2.00 grade points
$A-$	3.67 grade points	$C-$	1.67 grade points
$B+$	3.33 grade points	$D+$	1.33 grade points
B	3.00 grade points	D	1.00 grade points
$B-$	2.67 grade points	$D-$	0.67 grade points
$C+$	2.33 grade points	F	0.00 grade points

First Semester

Three required courses.

Area A. Basic functional analysis.

- CAM: CAM385c/M383c Methods of Applied Mathematics I
  CES: CAM386m/EM386m Functional Analysis in Theor. Mech. (or the CAM option course)

Area B. Basic numerical linear algebra

- CAM383c/CS383c Numerical Analysis: Linear Algebra

Area C. Basic applications and modeling

- CAM397 Introduction to Mathematical Modeling

Second Semester

Area A. One course required from

- CAM: Continuum. CAM385d/M383d Methods of Applied Math. II
  CES: Operational. EM386l Math. Methods in Applied Mech. or CAM381n/PHY381m Meth. of Math. Physics (or the CAM course)
- Probability. CAM384K/M385C Probability or EE381j Prob. & Stochastic Proc. I
- Discrete. CS388C Combinatorics and Graph Theory or M390c Discrete Mathematics.

Area B. One course required from

- Numerical analysis: CAM383D/CS383D Numerical Analysis or CAM397/PGE383 Scientific Computation
- Numerical diff. eqns.: CAM386K/M383G Num. Treatment of D. E.'s or CAM394F/EM394F Finite Element Methods
- Algorithms: CS388G, Algorithms: Techniques and Theory

Area C. One approved course (undergraduate level if appropriate). For the CAM option, this course may be delayed to the third semester.

Preliminary Examinations

- Three written exams (Areas A, B, and C) are given at the end of first year (May 2009).
- Covers the material of the 5 required first year courses.
- The student must demonstrate graduate level proficiency in the CAM Concentration Areas.
- Failure results in one of:
  - leave the program;
  - repeat that particular exam the following year;
  - take a make-up exam within 4 weeks.
- Success means you can concentrate your energy on Ph.D. level research!

Dissertation Adviser

The CAM Graduate Studies Committee (GSC) consists of the faculty who can advise Ph.D. students (a list is on the CAM web page).

Every student must select an adviser willing to supervise his or her dissertation by the end of the

CAM: third semester (December 2009)

CES: second semester (May 2009)

Prior to this, the Graduate Adviser and a faculty mentor will advise the student on course work.

Composition of the Graduate Studies Committee (GSC)

College of Natural Sciences faculty (52):

- 21 in Mathematics
- 11 in Computer Science
- 8 in Physics
- 6 in Chemistry & Biochemistry
- 4 in the School of Biological Sciences
- 2 in Astronomy

College of Engineering faculty (40):

- 13 in Aerospace Engineering & Engineering Mechanics
- 8 in Mechanical Engineering
- 7 in Electrical & Computer Engineering
- 4 in Petroleum & Geosystems Engineering
- 3 in Civil Engineering
- 3 in Chemical Engineering
- 2 in Biomedical Engineering

McCombs School of Business faculty (4):

- 3 in Management Science & Information Systems
- 1 in Finance

Jackson School of Geosciences (1):

- 1 in Geological Sciences

Next Five Semesters

Area A. Two additional approved graduate courses in Area A
(total 4 courses or 12 hours)

- At least 2 courses must be listed or cross-listed with the Mathematics Department.

Area B. Two additional approved graduate courses in Area B
(total 4 courses or 12 hours)

Area C. Two additional approved graduate courses in Area C
(total 4 courses or 12 hours)

- In some application area consistent with the student's proposed research area.
- Approved by both the student's dissertation adviser and the Graduate Adviser

Complete all coursework by *7th* semester (December 2011)

Ph.D. Dissertation Committee

- The dissertation committee consists of the adviser and faculty from:
  1. area A;
  2. area B;
  3. area C;
  4. any relevant area.
- At least three must be in different UT departments.
- The Graduate Adviser must approve the committee.

Dissertation Proposal

Before the end of the seventh semester (December 2011), the student must propose research for the Ph.D. dissertation.

Abstract

- Addresses how each of the three CAM concentration areas will form an integral part of the proposed research.
- About 2 pages.
- Approved by the GSSC: allow at least 1 month!

Proposal

- Statement of research problems and motivation.
- Demonstrate having the needed technical background.
- Sketch at least one potential method of attack.
- Preliminary work completed.
- Stages of future research.

Admission to Ph.D. Candidacy

Two weeks past submission of the dissertation proposal.

Part 1: Proposal presentation, about 45 minutes, public.

Part 2: Qualifying examination, private.

- Student's qualifying examination committee (dissertation committee, minus adviser, plus one GSSC examiner).
- The exam will test the depth and breadth of the student's knowledge relevant to the proposed research.
- Somewhat greater depth and breadth expected in
  CAM: Area A as opposed to Area C.
  CES: Area C as opposed to Area A.
- Failure: require additional course work and examination within 1 year.

Part 3: Graduate School application for admission to Ph.D. candidacy.

Ph.D. Dissertation and Defense

The Ph.D. Dissertation Committee judges the

- Final written dissertation.
- Oral defense.

For graduates over the past 6 years (Fall 2002–Summer 2008):

- 27 CAM Ph.D. graduates.
- Average time to degree was 5.76$\pm$1.64 years.
- Minimum 3.5 years, Median 5.5 years, Maximum 9 years.
- Numbers:
  3.5, 4, 4, 4, 4, 4, 4.5, 5, 5, 5, 5, 5, 5,
  5.5, 5.5,
  6, 6, 6, 6, 6, 7, 7, 7, 8.5, 9, 9, 9

Probation and Petitions

Probation: A student failing to satisfy the requirements of the program in a timely manner will be put on probation by the GSSC, and his or her progress will be monitored closely. The student will stay on probation until satisfactory progress is achieved. A student may stay on probation for a maximum of two long semesters. A student who has been on probation for a total of two long semesters and is found to be not in compliance with the timely requirements of the program will not be allowed to continue in the program.

Appeals and Petitions: The student may appeal to or petition the CAM GSSC for waiver or alteration of any CAM requirement, except for waiver of an exam or waiver of a Graduate School degree requirement. Written appeals or petitions should be submitted to the GSSC through either the Graduate Adviser or the CAM Chair.

ICES Seminars

Research seminars:

Research seminars are given most Tuesdays and Thursdays in the ICES seminar room, ACE 6.304.

ICES Forum:

Usually given around noon on Fridays, and targeting graduate students.

Your attendance is required! (10 seminars per semester)

Student Societies

Student Chapter of SIAM

Affiliated with the Society for Industrial and Applied Mathematics (SIAM). A society for all those interested in mathematics and its applications, any major, undergraduate, graduate, and faculty.
Sponsoring:

- guest speakers;
- regional meetings;
- career discussions on industry and academia;
- student-faculty social events;
- visits to annual SIAM meetings.

Student Chapter of USACM

Affiliated with the U.S. Association of Computational Mechanics.

First Year Summary

- Courses:
  - 2 Area A;
  - 2 Area B;
  - 1 Area C;
  - 1 any Area (CAM) or Area C (CES).
- Preliminary Examinations in late May.
- Seminar attendance (10 per semester).
- Selection of dissertation adviser by Dec. (CAM) or May (CES) of 2009.

2006–2007 CAM Ph.D. Dissertations

1. Cottrell, John Austin, *Isogeometric analysis and numerical modeling of the fine scales within the variational multiscale method.*
2. Heath, Ross, *Numerical analysis of the discontinuous Galerkin method applied to plasma physics.*
3. Kurtz, Jason, *Fully automatic HP-adaptivity for acoustic and electromagnetic scattering in three dimensions.*
4. Rath, James, *MUltiscale basis optimization for Darcy flow.*
5. Baird, John, *Numerical analysis of the representer method applied to reservoir modeling.*
6. Baird, John, *Numerical Analysis of the Representer Method Applied to Reservoir Modeling.*
7. Bazilevs, Jurijs, *Isogeometric Analysis of Turbulence and Fluid-Structure Interaction.*

2007–2008 CAM Ph.D. Dissertations

1. Santillana, Mauricio, *Analysis and numerical simulation of the diffusive wave approximation of the shallow water equations.*
2. Stogner, Roy, *Parallel adaptive C1 macro-elements for nonlinear thin film and non-Newtonian flow problems.*
3. Tharkabhushanam, Sri Harsha, *Conservative deterministic spectral method for rarefied gas flows.*
4. Iglesias-Hernandez, Marco, *An iterative representer-based scheme for data inversion in reservoir modeling.*
5. Bauman, Paul, *Adaptive multiscale modeling of polymeric materials using goal-oriented error estimation, Arlequin coupling and goals algorithms.*
6. Ciarleglio, Michael, *Modular abstract self-learning TABU search (MASTS) metaheuristic search theory and practice.*
7. Fuentes, David, *Computational modeling and real-time control of patient-specific laser treatment of prostate cancer.*
8. Khandelwal, Shweta, *Ecology of infectious diseases with contact networks and percolation theory.*
9. Sokolova, Ekaterina, *Dynamic indifference valuation in incomplete non-reduced models with a stochastic risk factor.*
10. Su, Qimou, *Essays on derivatives pricing in incomplete financial markets.*

Some Employers of CAM Graduates

- Industry
  1. AdaptCo, Texas
  2. Hostway Corporation, Illinois
  3. Lucent Technologies, New York
  4. Renaissance Technologies Corp., New York
  5. Schlumberger Austin Product Center, Texas
  6. Shell Oil
  7. Tibco Software Inc., California
- National Labs
  1. Lawerence Livermore National Laboratory, California
  2. Sandia National Laboratories, New Mexico
- Academics
  1. Chalmers University, Sweden
  2. North Carolina State University
  3. State University of New York Buffalo
  4. University of California, Berkeley
  5. University of Chicago
  6. University of Pittsburgh
  7. University of Texas at Austin
  8. Yale University

Welcome to CAM!

We all hope that your time here is stimulating, challenging, rewarding, and enjoyable!