COMPUTATIONAL SCIENCE, ENGINEERING & MATHEMATICS: PATH TO DEGREE

Fall 2022

Todd Arbogast

Chair of the Graduate Studies Committee

Center for Subsurface Modeling of the
Oden Institute for Computational Engineering and Sciences

and

Department of Mathematics

The University of Texas at Austin
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.
1973 Professor J. Tinsley Oden founds the Texas Institute for Computational Mechanics (TICOM) as a research group.

1993 TICOM becomes the Texas Institute for Computational and Applied Mathematics (TICAM) through gifts from the Peter O’Donnell, Jr., foundation (which total over $143 million to date).

- A graduate program is established in Computational and Applied Mathematics (CAM).

2001 Texas Advanced Computing Center (TACC) is established.

2003 TICAM becomes the Institute for Computational Engineering and Sciences (ICES) with a greatly expanded scope and expertise.

2010 CAM is renamed the Computational Science, Engineering, and Mathematics (CSEM) graduate program.

2019 ICES becomes the Oden Institute for Computational Engineering and Sciences.

The Oden Institute, CSEM, and TACC are intertwined...
The CSEM Degree Program

CSEM Students, Fall 2018
CSEM is interdisciplinary. To analyze, model, and simulate a system, researchers must develop a broad and deep understanding of the three CSEM Concentration Areas:

- **Area A.** Applicable mathematics;
- **Area B.** Numerical analysis and scientific computation;
- **Area C.** Applications and 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 CSEM dissertations must demonstrate an interdisciplinary theme and draw on knowledge from the three CSEM concentration areas.
CSEM Concentration Areas

**Area A, Applicable Mathematics.** Area A encompasses the mathematical theory and foundations underlying the scientific models and computational science addressed in the overall research effort. Functional analysis, partial differential equations, differential geometry, probability, data science, optimization, and approximation theory.

**Area B, Numerical Analysis and Scientific Computation.** Area B, encompasses all areas of algorithms and computational simulation, as well as their development, verification, and analysis. Numerical stability and approximation, scientific programming, visualization, parallel computation, software design, and high performance computing.

**Area C, Mathematical Modeling and Applications.** Area C encompasses the scientific principles of the natural, engineered, social, or other system that motivates the research and aims to foster some scientific or societal goal through computational modeling and simulation. Students develop a concentration of course work in a well-defined discipline of science, engineering, medicine, economics, or the social sciences.
Computational Science and Engineering (CS&E) is a multidisciplinary field concerned with the study, development, and use of computational methods and computers to enable scientific discovery and engineering applications.
CSEM Leadership (2022)

- Dr. Karen Willcox, Director of the Oden Institute
- Dr. Todd Arbogast, Chair of the Graduate Studies Committee (GSC)
- Dr. George Biros, Graduate Advisor
- Ms. Stephanie Rodriguez, Graduate Coordinator
- CSEM oversight: The Graduate Studies Subcommittee (GSSC)
Program Outcomes

1. Education and training
Each student will develop technical understanding of and graduate level proficiency in computational science, engineering, and mathematics, as defined by three interdisciplinary CSEM Concentration Areas.

2. Interdisciplinary Research
Each CSEM Ph.D. student will do original, interdisciplinary research in applied mathematics and computational science and engineering.

3. Communication Skills
Each student will be able to communicate research results intelligibly to a broadly trained audience, both in written and oral form. CSEM students will learn skills required to work in research groups to solve complex interdisciplinary problems.

4. The Scientific Community
The student will develop a broad understanding of the field of computational science and engineering, both inside and outside of his or her chosen field of application (Area C).

5. Employment
Each graduate will secure an entry level position in academia or a public or private research laboratory specializing in interdisciplinary computational science and engineering research or technical services.
Some Statistics of the CSEM program

Current (2021–22)

- 105 Students Enrolled
- 90 Students Enrolled in the Ph.D. program
- 39 Students on Fellowship (approx.)
- 53.3% US Students
- 34 CAM Option/56 CSE Option/15 Terminal MS
- 11 PhD Degrees Awarded 2020–21
- Average 6 Years to Degree Completion (2 yrs for MS, 4 yrs for PhD)
- About 15–25 new students enrolled each year
Degree Requirements
The CSEM web site:
https://www.oden.utexas.edu/academics/

Degree requirements:
- The CSEM Ph.D. requirements:
  https://www.oden.utexas.edu/academics/phd-program/
- The CSEM M.S. requirements:
  https://www.oden.utexas.edu/academics/masters-program/

These slides: (from T. Arbogast's home page)
http://users.oden.utexas.edu/%7Earbogast/CSEMoverview.pdf

CSEM Wiki page:
https://wiki.oden.utexas.edu/csem
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. Note: Ph.D. candidates will fulfill this requirement. Be sure to request your degree!

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 Advisor.
- At least 24 hours taken for a letter-grade in the 3 CSEM Areas.
- At least 6 hours in each CSEM Area.
- All Graduate School requirements must be fulfilled.
- Overall grade point average 3.0 (B) or better.
- Reports and Theses require an advisor from the CSEM GSC and a reader to approve the document.
Master’s Report vs. Thesis

No university document distinguishes clearly between a report and a thesis in terms of length or scope.

**CSEM policy:**

- A report is a library project, reviewing what scholars have said about a particular topic.
- A thesis is an original contribution to knowledge in which a novel analysis or argument is offered, a problem is analyzed using a new or previously untried framework, or data about a subject is collected and analyzed.
- The work required to produce the document is expected to be equivalent to 3 credit hours for a report and 6 for a thesis.
1. **Coursework.** 12 courses total, 4 in each of the 3 areas. 6 core courses required in the first year. GPA 3.25 or better.

2. **Preliminary Exams.** Areas A, B, and C exams at end of first year.

3. **Ph.D. Dissertation Committee.** The adviser, faculty from Areas A, B, and C, and 1 more. At least 3 from different UT departments.

4. **Admission to Ph.D. Candidacy.** Student proposes plan of research.
   - **Abstract.** How Areas A, B, and C form an integral part of the proposed research. Approved by GSSC.
   - **Dissertation proposal.** Approved by the Dissertation Committee.
   - **Candidacy exam.** Tests depth and breadth of knowledge. Administered by the Dissertation Committee.

5. **Ph.D. Degree.** Dissertation and oral defense.
1. Coursework
Ph.D. Degree Options

Two starting points (the two degree options):

1. Computational and Applied Mathematics (CAM) Option
   [more math, less applications background]
2. Computational Science and Engineering (CSE) 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 with a major in Computational Science, Engineering, and Mathematics
Required Grade Point Average

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

You must maintain a B average to remain in graduate school.
First Semester

Three required courses.

**Area A. Functional analysis**
- **CAM:** CSE 386C/M 383C Methods of Applied Mathematics I
- **CSE:** CSE 386M/EM 386M Functional Analysis in Theoretical Mechanics

**Area B. Numerical linear algebra**
- CSE 383C/CS 383C Numerical Analysis: Linear Algebra

**Area C. Applications and modeling**
- CSE 389C Introduction to Mathematical Modeling in Science and Engineering I
Second Semester

Three required courses.

**Area A. Mathematical Methods**
- **CAM:** CSE 386D/M 383D Methods of Applied Mathematics II
- **CSE:** CSE 386L/EM 386L Mathematical Methods in Engineering and Science

**Area B. One course chosen from:**
- CSE 383L/M 387D Numerical Treatment of Differential Equations
- CSE 3832M Foundational Techniques of Machine Learning and Data Sciences

**Area C. Applications and modeling**
- CSE 389D Introduction to Mathematical Modeling in Science and Engineering II
Complete all coursework by 7th semester (December 2025)

**Area A.** Two approved graduate courses (total 4 courses or 12 hours)
- At least 2 courses must be listed or cross-listed with the Mathematics Department.

**Area B.** Two approved graduate courses (total 4 courses or 12 hours)
- Optional CSE 380 Tools and Techniques in Computational Science
  *If you are not already an expert, please take this course!*
- One course could be at the undergraduate level, if appropriate.

**Area C.** Two approved graduate courses (total 4 courses or 12 hours)
- In a field consistent with the student’s proposed research area.
- One course could be at the undergraduate level, if appropriate.
- Approved by both the student’s dissertation advisor and the Graduate Advisor.
2. Preliminary Examinations
Preliminary Examinations

• Three written exams are given at the end of first year:
  • Area C Wednesday, May 10, 2023;
  • Area B Friday, May 12, 2023;

• Covers the material of the 6 required first year courses (each student is tested on the courses he or she took).

• The student must demonstrate graduate level proficiency in the CSEM Concentration Areas.

• Failure results in one of:
  • take a make-up exam before the start of the Fall semester;
  • repeat that particular exam the following year;
  • leave the program.

• Success means you can concentrate your energy on Ph.D. level research!
3. Ph.D. Dissertation Committee
The CSEM Graduate Studies Committee (GSC) consists of the faculty who can advise Ph.D. students (a list is on the CSEM web page).

Every student must select an advisor willing to supervise his or her dissertation and give advice on course work. You must find an advisor during your first year, that is, by May 2023.

Prior to this, the Graduate Advisor and possibly a faculty mentor will advise the student on course work.
Composition of the Graduate Studies Committee (GSC)

All faculty have home departments

Total faculty: 65 (8 in two departments, 1 in three, 1 in four)

**College of Natural Sciences faculty (30):**

<table>
<thead>
<tr>
<th>Department</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>14</td>
</tr>
<tr>
<td>Computer Science</td>
<td>7</td>
</tr>
<tr>
<td>Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Physics</td>
<td>3</td>
</tr>
<tr>
<td>Integrative Biology</td>
<td>2</td>
</tr>
<tr>
<td>Molecular Biology</td>
<td>1</td>
</tr>
</tbody>
</table>

**Cockrell School of Engineering faculty (40):**

<table>
<thead>
<tr>
<th>Department</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engineering &amp; Engineering Mechanics</td>
<td>18</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>8</td>
</tr>
<tr>
<td>Biomedical Engineering</td>
<td>6</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>1</td>
</tr>
<tr>
<td>Electrical &amp; Computer Eng.</td>
<td>3</td>
</tr>
<tr>
<td>Petroleum &amp; Geosystems Eng.</td>
<td>2</td>
</tr>
<tr>
<td>Civil &amp; Environmental Eng.</td>
<td>2</td>
</tr>
</tbody>
</table>

**Other Units of the University (8):**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jackson School of Geosciences</td>
<td>5</td>
</tr>
<tr>
<td>Dell Medical School</td>
<td>2</td>
</tr>
<tr>
<td>Oden Institute</td>
<td>1</td>
</tr>
</tbody>
</table>
Ph.D. Dissertation Committee

- The dissertation committee consists of the advisor and faculty from:
  1. area A;
  2. area B;
  3. area C;
  4. any relevant faculty outside the GSC.
- At least three must be in distinct UT departments through positive time appointment.
- The Graduate Advisor must approve the committee.
4. Admission to Ph.D. Candidacy

Before the end of the sixth semester (August 2025),
the student must propose research for the Ph.D. dissertation.
Proposal Abstract

Write: Write a concise abstract of the dissertation proposal.
- About 0.5 page listing the proposal title, your name, advisor, and committee members.
- About 0.5 to 1 page giving general background on the research area and identification of the problems to be addressed.
- About 1 to 1.5 pages discussing how Areas A, B, and C will form an integral part of the proposed research.
- The text of the abstract content (not titles, etc.) must fit in 2 pages.
- Perhaps 0.5 page of important references and possibly courses taken.

Meet: Meet with each member of the dissertation committee to discuss:
- the abstract
- the role of the committee member
- the background knowledge expected of the student and types of questions that might be asked at the proposal presentation

The abstract must be signed by each member of the committee.

Submit: Submit to the GSSC for approval. Allow at least 1 month!

Is the research interdisciplinary and draw on Areas A, B, and C?
The proposal must be set in 11 or 12 point font and conform to standard U.S. letter dimensions using one inch margins.

1. **Title page.** Title, student, date, committee.
2. **Proposal abstract.**
3. **Description of the proposed work.** At most 20 pages.
   a. Technical background and relevant literature
   b. Objectives, significance, and originality
   c. Work completed to date
   d. Work yet to be completed and methodology or approach
4. **References.**
5. **Vita.** One to two page vita: degrees earned, awards, papers published or in preparation, and technical talks or posters.
6. **Timeline.** To complete the proposed work.
7. **Appendices.** At most 10 pages of additional material.

**Remark.** The structure is like a research grant proposal.
Admission to Ph.D. Candidacy

Two weeks past submission of the dissertation proposal.

**Part 1:** Private oral presentation to the committee, about 45 minutes.

**Part 2:** Qualifying examination by the committee, about 1 hour.
- Explore details of the proposal
- Test depth and breadth of background knowledge relevant to the proposed research
- Test ability to integrate ideas from areas A, B, and C
- Failure: require additional course work and examination within 1 year.

**Part 3:** Graduate School application for admission to Ph.D. candidacy.
5. Ph.D. Degree
**Dissertation:** A written dissertation ("long essay") of research results, generally advocating a coherent thesis ("a statement or theory put forward as a premise to be maintained or proved").

**Defense:**
- Public, oral seminar presentation of about 45 minutes plus questions.
- Private meeting with the dissertation committee to face questions and orally defend the work.

The dissertation committee must approve both the dissertation and the defense.

- Should complete by the end of the tenth long semester (May 2027).
- Practically must be completed before the end of the fourteenth long semester (May 2029).

The dissertation and oral defense must follow appropriate Graduate School requirements and procedures.
• Last 6 years (Fall 2015–Summer 2021): 57 CSEM Ph.D. graduates.
• Time to earn MS degree is 2 years.
• Average time to earn PhD degree was 4.0±1.2 years.
• Average time to MS plus PhD degrees was 6.0±1.2 years.
• Minimum 3.5 years, Median 6 years, Maximum 11 years.
6. Miscellaneous
**Regular Duties**

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**Oden Institute Seminars**

- **Research seminars:**
  Research seminars most Tuesdays and Thursdays at 3:30 in the seminar room, POB 6.304.

- **Oden Institute Forum:**
  Around noon on Fridays targeting graduate students.

Your attendance is required! (10 seminars per semester)

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**Annual Progress Reports**

Each student is required to prepare an annual progress report of

- coursework
- financial support
- research activities
- dissertation committee
- area C concentration
- expected date for proposal
- expected date for defense
- etc.
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.

Appeals and Petitions: The student may appeal to or petition the CSEM GSSC for waiver or alteration of any CSEM requirement, except for waiver of an exam or waiver of a Graduate School degree requirement.
First Year Summary

- Courses
  - 2 Area A
  - 2 Area B
  - 2 Area C

- Preliminary Examinations in late May
- Seminar attendance (10 per semester)
- Selection of dissertation advisor by May 2023
- Annual progress report (due early in the Fall 2023)

Formulate a coherent area of application (Area C)!

- Study the area you are trying to impact.
- Engage the science, engineering, and/or social science disciplines.
- Mathematics and computer science give tools (Areas A & B) out of context. The application area is the context.
CSEM Ph.D. Degree Summary

1. Coursework. 12 courses total, 4 in each of the 3 areas, 6 core courses required in the first year. GPA 3.25 or better (one 3.5 or better).


3. Ph.D. Dissertation Committee. The adviser (select by end of year), faculty from Areas A, B, and C, and 1 more. At least 3 from different UT departments.

4. Admission to Ph.D. Candidacy. Student proposes plan of research.
   - Abstract. How Areas A, B, and C form an integral part of the proposed research. Approved by GSSC.
   - Dissertation proposal. Approved by the Dissertation Committee.

Building Community

**Within CSEM**

- First year courses and offices.
- Student Lounge.
- CSEM student leaders organize **socials** and bring concerns to faculty.
- Everyone is in the Peter O’Donnell Building.

[COVID-19 presents a challenge, but we must prevail!]

**Outside CSEM**

- Student Chapter of the Society for Industrial and Applied Mathematics (SIAM), for all those interested in mathematics and its applications: any major, undergraduate, graduate, and faculty.
Research in the Oden Institute

Some of the Oden Institute Core Faculty

Peter O’Donnell, Jr. Building for Applied Computational Engineering & Sciences (POB)
The Oden Institute is home to more than 400 People!

- **Core Faculty**: 45
- **Affiliated Faculty**: 77
- **Research Staff**: 37
- **Post-docs**: 42
- **CSEM Students**: 98
- **non CSEM Students**: 93
- **Visiting Scholars**: 10
- **Affiliated Faculty**: 77
- **Research Staff**: 37
- **Post-docs**: 42
Oden Institute’s 25 Research Centers—1

*Life Sciences and Medicine (3)*
- Center for Computational Life Sciences and Biology (Elber)
- Center for Computational Oncology (Yankeelov, Oden, Rylander)
- Willerson Center for Cardiovascular Modeling and Simulation (Sacks et al.)

*Physical Sciences (6)*
- Center for Computational Materials (Chelikowsky, Demkov)
- Center for Computational Molecular Science (Henkelman, Bonnecaze, Makarov)
- Center for Quantum Materials Engineering (Giustino)
- Computational Astronautical Sciences and Technologies (Jah)
- Computational Mechanics Group (Hughes et al.)
- Electromagnetics and Acoustics Group (Yilmaz, Demkowicz)
Geosciences (4)

- Center for Computational Geosciences and Optimization (Ghattas, Bui-Thanh, Heimbach)
- Center for Subsurface Modeling (Wheeler, Arbogast, Delshad)
- Computational Hydraulics Group (Dawson)
- Computational Research in Ice and Ocean Systems Group (Heimbach)
Oden Institute’s 25 Research Centers—3

Computational Science and Engineering (6)

- Autonomous Systems Group (Topcu)
- Multiscale Engineering, Mathematics and Sciences Group (Aluru)
- Parallel Algorithms for Data Analysis and Simulation Group (Biros)
- Predictive Engineering and Computational Science (Moser et al.)
- Probabilistic and High Order Inference, Computation, Estimation, and Simulation [Pho-Ices] (Bui-Thanh)
- Willcox Research Group (Willcox)

Mathematics and Computer Science (6)

- Applied Mathematics Group (Gamba et al.)
- Center for Distributed and Grid Computing (Pingali)
- Center for Numerical Analysis (Engquist et al.)
- Center for Scientific Machine Learning (Ward, Willcox, et al.)
- Computational Visualization Center (Bajaj, Dhillon)
- Science of High-Performance Computing Group (Van de Geijn, Myers)
## Oden Institute Research Metrics

<table>
<thead>
<tr>
<th>Faculty Metric</th>
<th>2017-18</th>
<th>2018-19</th>
<th>2019-20</th>
<th>2020-21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affiliated Faculty</td>
<td>118</td>
<td>123</td>
<td>122</td>
<td>121</td>
</tr>
<tr>
<td>Core Faculty</td>
<td>46</td>
<td>47</td>
<td>46</td>
<td>50</td>
</tr>
<tr>
<td>Medals, Prizes &amp; Honors</td>
<td>82</td>
<td>87</td>
<td>82</td>
<td>73</td>
</tr>
<tr>
<td>Refereed Journal Publications</td>
<td>337</td>
<td>312</td>
<td>384</td>
<td>362</td>
</tr>
<tr>
<td>Total Citations</td>
<td>670,915</td>
<td>764,019</td>
<td>902,665</td>
<td>937,450</td>
</tr>
<tr>
<td>Editorial Boards</td>
<td>181</td>
<td>179</td>
<td>163</td>
<td>186</td>
</tr>
<tr>
<td>Seminars &amp; Lectures</td>
<td>351</td>
<td>332</td>
<td>350</td>
<td>413</td>
</tr>
<tr>
<td>Workshops Hosted</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Active Research Projects</td>
<td>193</td>
<td>187</td>
<td>207</td>
<td>197</td>
</tr>
<tr>
<td>Total Funding</td>
<td>$71.3M</td>
<td>$70.6M</td>
<td>$74.1M</td>
<td>$89.6M</td>
</tr>
<tr>
<td>Income</td>
<td>$14.6M</td>
<td>$24.3M</td>
<td>$21.2M</td>
<td>$29.3M</td>
</tr>
<tr>
<td>Expenses</td>
<td>$18.9M</td>
<td>$19.7M</td>
<td>$19.6M</td>
<td>$21.5M</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Metric</th>
<th>16-17</th>
<th>17-18</th>
<th>18-19</th>
<th>19-20</th>
<th>20-21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total enrollment</td>
<td>74</td>
<td>82</td>
<td>80</td>
<td>98</td>
<td>101</td>
</tr>
<tr>
<td>Presented papers/seminars</td>
<td>42</td>
<td>38</td>
<td>40</td>
<td>35</td>
<td>53</td>
</tr>
<tr>
<td>Authored or coauthored articles</td>
<td>37</td>
<td>32</td>
<td>41</td>
<td>41</td>
<td>45</td>
</tr>
</tbody>
</table>
Recent CAM/CSEM Ph.D. Graduates

Graduation 2022
1. PolyDPG: A Discontinuous Petrov-Galerkin Methodology for Polytopal Meshes with Applications to Elasticity, Jaime Mora Paz, 2020, Advisor: Leszek Demkowicz.


1. Alghamdi, Amal; Bayesian inverse problems for quasi-static poroelasticity with application to ground water aquifer characterization from geodetic data
2. Bremer, Maximilian; Task-based parallelism for hurricane storm surge modeling
3. Estes, Samuel; Uncertainty quantification in reservoirs with faults using a sequential approach
4. Lei, Qi; Provably effective algorithms for min-max optimization
5. Ly, Louis; Visibility optimization for autonomous exploration and surveillance-evasion games
6. Myers, Aaron; Particle methods for Bayesian inverse problems governed by partial differential equations
7. Nguyen, Hieu; Parallel-in-time methods for wave propagation in heterogeneous media
8. O’Leary-Roseberry, Thomas; Efficient and dimension independent methods for neural network surrogate construction and training
9. Portone, Teresa; Representing model-form uncertainty from missing microstructural information
10. Tharakan, Sameer; Using globally low-rank kernel matrix approximations in machine learning and uncertainty quantification
11. Wahal, Siddhant; Novel algorithms for uncertainty quantification in large scale systems
12. Zhang, Jiong; Efficient deep learning for sequence data
Recent CSEM Employment (past 4 years)

**Industry**
- Akuna Capital LLC
- Amazon
- Chevron
- CognitiveScale
- Dimensional Fund Advisors
- DTU Compute
- Element AI
- Enthought Inc.
- Facebook
- Schlumberger
- Snap Inc.
- Suited Inc.

**Academics**
- Brigham Young University
- Cornell University
- Delft University of Technology
- Nazarbayev University
- New York University
- Princeton University
- Technical University of Munich
- University of Basel
- University of Colorado Boulder
- University of Hannover (Leibniz)
- University of Texas at Austin

**Government**
- Argonne National Laboratory
- Federal Reserve Bank, Atlanta
- Lawrence Berkeley Nat’l Lab.

- Lawrence Livermore Nat’l Security, LLC
- Sandia National Labs
CSEM First Job After Graduation

Total (since 1995)

- Postdoc: 75
- Industry: 49
- Gov't Labs: 13
- Teaching: 10

Last 6 years (since 2015-16)

- Postdoc: 27
- Industry: 20
- Gov't Labs: 6
- Teaching: 3
Welcome to CSEM!
We hope your time here is stimulating, challenging, rewarding, and enjoyable!