



**Mechanical &
Aerospace Engineering**

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Guidelines for those interested to apply for their PhD to the MPDC laboratory

This document has been written with a single purpose in mind: To provide applicants interested to work for their PhD in our laboratory with a direct view of the needed qualifications, and type of research work that is performed in our laboratory that forms the core of the doctoral work of the participating students.

The research interests of our laboratory are in stochastic and statistical multiscale multiphysics computational modeling of materials and all incoming students are expected to work in various aspects of this area. This research area combines expertise in the physical sciences (e.g. materials) and skills in computational mathematics and scientific computing.

This work is for creative and analytical minds with appetite for scientific computing and exploring physical modeling often beyond the boundaries of traditional engineering

The predictive science emphasis of our work is in the frontier of computational mathematics and scientific computing and completion of a PhD with us provides many (academic, national laboratory and industrial) opportunities for employment.

Common Background of all PhD students in our laboratory: (a) High Performance Computing, (b) Various aspects of mathematical modeling, (c) Computational (Bayesian) statistics and stochastic modeling.

Particular focus topics for PhD: (a) Several problems in predictive materials science, (b) Uncertainty quantification in multiscale materials problems, (c) Using machine learning approaches (e.g. probabilistic graphical models) for stochastic multiscale modeling, (d) Solution of high-dimensional stochastic PDEs using collocation, spectral and Bayesian approaches, (e) Mathematical and statistical approaches to coarse graining, (f) The materials genome (exploring process/structure/property relations using Bayesian machine learning approaches), (g) Several data-driven

inference problems relevant to multiscale materials modeling and design, (h) Model reduction in complex stochastic systems and (i) Exascale computing.

When applying, please document how your background and interests interface with our laboratory's research objectives

We are interested in producing productive researchers capable for independent work in technologically important and relevant areas of computational science. The best measures for their success are the quality of their published work and their careers after graduation.

The emphasis of the MPDC laboratory and its members is by educating the best minds to learn and produce new knowledge that advances computational science and engineering while helping our industrial and federal sponsors in their mission

We list below general requirements for those interested to apply to our program (you are encouraged to contact Prof. Zabarar if you have any questions on the requirements of our laboratory):

1. **We are looking for self-motivated, dedicated, intelligent and hard working individuals with a demonstrated ability for systematic creative thinking.**
2. **You need to have a demonstrated excellent academic record (in particular in mathematics, computation and the sciences).** Students with an MS degree are especially encouraged to apply.

You can document your background in this area by stating in your application (can also Email us this information) (i) your relevant courses and grades, (ii) actual programming assignments showing your competence in C++, (iii) projects, theses, readings in areas relevant to our research, etc.

3. **We welcome students from around the world. Your TOEFL scores need to satisfy reading (20), writing (20), listening (15), and speaking (22) and your GRE scores need to be competitive.**
4. **At least one teleconference (via Skype) will be conducted before any final admission decisions are taken. We encourage visits to our laboratory. Conducting current students in our laboratory and discussing their work and experiences is also highly recommended.**

5. Undergraduate students from any Engineering field are invited to apply. Students with degrees in Applied/Computational Mathematics or Applied Physics/Applied Mechanics are particularly encouraged.

A few other comments are discussed briefly below:

- 1) **What do we expect from PhD students in their first year at Cornell?**
Demonstrating that they can **understand and present with clear technical English research-oriented topics and step-by-step reproduce simple results from the published work of others.**
 - **First year students need to be integrated with our research objectives.**
Your education (courses, research and training) need to be focused in the broad areas relevant to our research.
 - Each student is expected that in addition to taking graduate courses, he/she will also devote time for critical reading of research publications in a designated area, write small C++ programs to implement fundamental problems, give presentations to group members and by the end of the second year evolve to a productive researcher.
 - **Collaborating and working closely with other students in the laboratory as well as with our collaborators elsewhere (e.g. National Laboratories, industry) is in essential requirement for success.**
- 2) **C++ parallel programming should become a facilitator and not a barrier to our research. Our laboratory is participant and key user of some of the fastest supercomputers in the country and the world including [Jaguar](#), [NERSC](#), etc.** These computers are designed for addressing systems of unique complexity and allow us to address problems of technological relevance.
- 3) In addition to many research benefits of early exposure to research (e.g. creating an excellent publication record, interacting with many researchers in other universities and national laboratories, presenting your work in international meetings, having many opportunities for summer internships in sponsoring government and industrial laboratories, etc.), **this approach allows the students committed and qualifying to work with us to complete their PhD studies in 4 years from their BS degree.** Many of our graduating students are ready upon graduation for academic or industrial R&D jobs without any need for postdoctoral studies.

- 4) **Typical summer internship opportunities for MPDC students include working with collaborators at national laboratories ([Sandia](#), [PNNL](#), [ORNL](#), [LLNL](#), [AFRL](#), ..) and industrial R&D ([UTRC](#), [GE](#), ..).**
- 5) In your CV (or your application statement of purpose) be sure you indicate what your interests are and why they are relevant to those of our laboratory. For sure **acknowledge in your application reading this document.**
- 6) Please note that we do not anticipate undergraduate students applying to our program to have direct background in our research areas. Most of the times we don't really care about you prior research experience but what your demonstrated analytical ability is to learn fast new things in our key focus research areas.

A few final notes:

- (a) **Follow the guidelines for admission described at the Cornell Graduate School:** Follow the application procedure described on the [Cornell Graduate School](#) web site (e.g. see the [Mech. Eng](#) or the [Aerospace Eng.](#) web sites). A complete application means that (1) you have submitted electronically your statement of purpose and CV, (2) paid the application fee, (3) submit your TOEFL and GRE scores as well as your transcripts and (4) have 3 recommendation letters submitted electronically. Planning early is helpful.
- (b) **MS vs. PhD:** Our laboratory does not admit students for the MS degree.
- (c) **Cornell graduate fields:** We admit students through the Mech Eng., Aero. Eng, Mat. Science and Eng. & Applied Math. fields.

We strongly encourage well qualified students to take the journey to Ithaca. ¹

ITHACA

As you set out for Ithaca
hope your road is a long one,
full of adventure, full of discovery.
Laistrygonians, Cyclops,
angry Poseidon - don't be afraid of them:
you'll never find things like that one on your way
as long as you keep your thoughts raised high,
as long as a rare excitement
stirs your spirit and your body.
Laistrygonians, Cyclops,
wild Poseidon - you won't encounter them
unless you bring them along inside your soul,
unless your soul sets them up in front of you.

Hope your road is a long one.
May there be many summer mornings when,
with what pleasure, what joy,
you enter harbours you're seeing for the first time;
may you stop at Phoenician trading stations
to buy fine things,
mother of pearl and coral, amber and ebony,
sensual perfumes of every kind -
as many sensual perfumes as you can;
and may you visit many Egyptian cities
to learn and go on learning from their scholars.

Keep Ithaca always in your mind.
Arriving there is what you're destined for.
But don't hurry the journey at all.
Better if it lasts for years,
so you're old by the time you reach the island,
wealthy with all you've gained on the way,
not expecting Ithaca to make you rich.

Ithaca gave you the marvellous journey.
Without her you wouldn't have set out.
She has nothing left to give you now.
And if you find her poor, Ithaca won't have fooled you.
Wise as you will have become, so full of experience,
you'll have understood by then what these Ithacas mean.

¹ [Constantine P. Cavafy](#) (1911).