

Program Policy Statement

Graduate Certificate in

Computing and Data Science for Soft Materials

University of Delaware, Newark

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Graduate Certificate in *Computing and Data Science for Soft Materials*

University of Delaware Program Policy Statement

Part I. Program History and Purpose

The proposed interdisciplinary based graduate Certificate in *Computing and Data Science for Soft Materials* prepares students to use high performance computing and data science to discover, innovate, and engineer new synthetic and biologically relevant soft (specifically polymeric) materials with tailored properties and function.

The 9-credit curriculum and professional training activities are designed to provide graduate students convergent and interdisciplinary technical training in soft materials modeling, simulations, experiments, computing, and data analytics, supplemented with close and regular interactions with mentors from relevant industries, national labs, and members in academia. The training elements, the timing and order of the elements—is chosen deliberately to have a logical flow and progression starting from a strong disciplinary foundation to incrementally infusing interdisciplinary training through convergent research and coursework combined with development and practice of technical and broad communication skills through teamwork, leadership, and peer-mentoring experiences. The integrated technical and professional training elements will prepare the graduate students to be career-ready for multiple career paths academic, non-profit, and private sectors.

A. National Science Foundation NRT award

This proposed graduate Certificate is based on the success of the current National Science Foundation NRT Computing and Data Science training for Materials Innovation, Discovery, AnalysicS (or MIDAS) traineeship grant (PI Prof. Arthi Jayaraman) which was awarded in September 2021. The first cohort of students applied to this traineeship program in Fall of 2021 and the selected students began their tenure in the NRT – MIDAS program as ‘NRT trainees’ in January of 2022. At the time of this proposal application, this program has two cohorts and each cohort has had an average of 10 graduate students, mostly enrolled in PhD degree in the University of Delaware’s Materials Science and Engineering, Biomedical Engineering, Chemical and Biomolecular Engineering, Chemistry and Biochemistry, Computer and Information Sciences, Electrical and Computing Engineering programs, or in the MS and PhD degree program in Delaware State University’s Chemistry department.

B. Purpose and rationale

A graduate student who earns the Computing and Data Science for Soft Materials graduate Certificate will be able to:

- Identify, develop, and/or apply the appropriate type of molecular modeling and simulation and/or machine learning based tools to find answers to any given technical question in soft materials field.
- Collaborate effectively in interdisciplinary environments by engaging with experimentalists working in the field of soft materials or computing experts regardless of the student’s own primary discipline (high performance computing/data science/soft materials/chemical

sciences).

- Effectively communicate – orally and in writing – technical concepts/ideas/results to any audience regardless of their scientific background/expertise in the technical area.
- Make informed decisions about their career path – industry R&D, academia, national lab research, science policy, patent law – by finding which route best fits their interests and strengths.
- Understand the responsibilities of scientists, researchers, and technical leaders in conveying the importance of their discovery/innovation to the general public

Students who earn this Certificate, in tandem with their own primary discipline's MS/PhD degree, will have additional technical knowledge and interdisciplinary skills and critical professional skills that expand their career options. For example, through interdisciplinary exploration of computing and data science for soft materials, our graduates can support industry leaders to improve equitable access to the materials data, science, and technology knowledge that could reduce costs by eliminating trial-and-error based materials exploration and promote sustainability through lean manufacturing.

C. Date of Permanent Status

This proposal is under review during AY2022-23 as a new program to start as soon as possible.

D. Degrees offered

Graduate Certificate.

Those who complete all requirements will be awarded a Graduate Certificate in *Computing and Data Science for Soft Materials* from the University of Delaware.

E. Term when first students may enroll

Students who are already selected to be a part of the NSF NRT Traineeship program began enrolling in Fall 2021. These students have already started completing the expected course work and professional development elements of this certificate program. Hence, they will be the first cohort of students eligible to enroll for this certificate and receive the certificate upon successful completion of all requirements.

F. Factors that identify the student demand for the program

There is demonstrated interest among graduate students in UD's College of Engineering and College of Arts & Sciences and DSU (Chemistry and Applied Physics) who wish to augment their knowledge gained in their primary degree disciplines. The evidence of this demonstrated interest is in increasing number of applicants to CBE and MSEG graduate programs that specifically mention the NSF NRT MIDAS traineeship in their applications. They note that the training elements in the NSF NRT MIDAS program (which are the same as this graduate certificate program) is their motivating factor to apply to UD for their graduate studies. These applicants also note that their participating in the NRT MIDAS professional development activities, which are the same as this graduate certificate, would give them an additional practical experiences. All of this together will further their professional endeavors.

It is expected that although this graduate certificate is primarily designed as a value-added credential to a UD or DSU MS/PhD graduate degree, this graduate certificate may also be of

interest to professionals who are employed in private, non-profit, and public organizations that seek to improve their interdisciplinary knowledge and training in computing, data science, and soft materials.

G. Identify the College and Department/School in which the program will reside

This Graduate Certificate program will be administered by UD Graduate College.

This Graduate Certificate program will have a Director (tenured faculty member from Chemical and Biomolecular Engineering/Materials Science and Engineering/Computer and Information Sciences/Data Science Institute) and an Administrative Coordinator.

Part II. Admission

The admissions process involves soliciting applications from first year MS/PhD graduate students already enrolled in their primary disciplines; specifically, the graduate programs in the College of Engineering's Materials Science and Engineering, Biomedical Engineering, Chemical and Biomolecular Engineering, Computer Information Science, and Electrical and Computing Engineering departments and the College of Applied Sciences' Chemistry and Biochemistry department. By the time of the application to this certificate program (i.e., by the end of their first semester or second semester at UD), these students must be in good academic standing and in the case of PhD students must have been assigned a primary research thesis advisor in their own department.

Applications will be reviewed, and decisions made by the Graduate Certificate Director and Administrative Coordinator and may involve input from other faculty members in the different academic units, depending upon need and interest.

Admission to the certificate program is selective and competitive based on

- a) applicants' research interest alignment with high performance computing, data science, and/or soft materials,
- b) their academic record, and
- c) the quality of their responses in the essays in the application

A. Admission Requirements for External Applicants

External applicants (DSU Chemistry graduate students) must submit the online graduate admission application (application fee will be waived) which includes the following:

<https://grad-admissions.udel.edu/apply/>

1. At least one letter of recommendation from their department's chairperson/head/graduate program director or a formal official in the university's registrar office confirming enrollment in the applicant's current graduate degree program and attesting to the candidate's ability to succeed in this graduate certificate program.
2. Current resume or Curriculum Vitae (CV)
3. Personal statement from the candidate expressing their motivation to apply to the certificate program, their interest in the type of interdisciplinary learning and learning goals that this certificate addresses.

An in person/virtual interview may be required. Relevant work experience may also be taken into consideration.

B. Admission Requirements for University of Delaware Students Who Are Currently Enrolled in select Graduate Degree Programs

This *Computing and Data Science for Soft Materials* Graduate Certificate program is relevant for (MS/PhD) graduate students enrolled in College of Engineering's Materials Science and Engineering, Biomedical Engineering, Chemical and Biomolecular Engineering, Computer Information Science, and Electrical and Computing Engineering departments and the College of Applied Sciences' Chemistry and Biochemistry department. These students may apply to the Certificate program by completing the appropriate application form listed below:

Certificate application for graduate students already enrolled at UD in a graduate program:
<https://www.udel.edu/content/dam/udelImages/grad-college/graduate-college-pdfs/gradcertificate-enrollment.pdf>

Upon receipt of the application form, graduate students will be notified to submit the following:

1. At least one letter of recommendation from their department's chairperson/head/graduate program director/faculty advisor confirming enrollment in the applicant's current graduate degree program and attesting to the candidate's ability to succeed in this graduate certificate program.
2. Current resume or Curriculum Vitae (CV)
3. Personal statement from the candidate expressing their motivation to apply to the certificate program, their interest in the type of interdisciplinary learning and learning goals that this certificate addresses.

An in person/virtual interview may be required.

1. Application deadlines

University of Delaware (UD) graduate students may apply in Fall semester of their first year as a graduate student at UD. External applicants from DSU will also apply in the Fall but can be in their second year of their degree program provided they still have two more years until expected graduation date. All applications (internal and external) must be submitted by November 30th of each year.

2. Special competencies needed

Applicants must come from the following graduate majors: UD's Materials Science and Engineering, Biomedical Engineering, Chemical and Biomolecular Engineering, Chemistry and Biochemistry, Computer Information Science, Electrical and Computing Engineering, and DSU's Chemistry.

3. Admission categories (explain other than regular such as provisional)

None.

4. University statement:

Admission to the graduate certificate program is competitive. Those who meet stated requirements are not guaranteed admission, nor are those who fail to meet all of those requirements necessarily precluded from admission if they offer other appropriate strengths.

Part III. Academic

A. Degree Requirements

1. Course requirements

This Certificate requires at least 9 course credits as listed below.

REQUIRED COURSES (3 credits)

- CHEG/ECEG/CISC/MSEG 848 Computing and Data Science for Soft Materials Innovation (3 credits) Spring semester

RESTRICTED ELECTIVE(S)

For Computer Information Science and Electrical and Computing Engineering Students

Students in Computer Information Science or Electrical and Computing Engineering must choose from any of the following three credit electives offered as graduate electives in Computer Information Science and Electrical and Computing Engineering departments as their **Primary Discipline** Elective.

- BINF 684 - Introduction to Machine Learning
- CISC662 Computer Systems: Architecture
- CISC 681 - Artificial Intelligence
- CISC684 Introduction to Machine Learning
- CISC 642 - Introduction to Computer Vision
- ELEG 602 - Advanced Machine Learning
- CISC 879 - Advanced Topics in Architecture and Software Systems
- CISC 882 - Natural Language Processing
- ELEG 817 - Large Scale Machine Learning
- ELEG 845 - Modern Machine Learning

Students in Computer Information Science or Electrical and Computing Engineering must choose from one of these three credits from these as a **Secondary Discipline** Elective Course:

- CHEG 647/847 Molecular Modeling and Simulations of Soft Materials
- MSEG 631 Organic Electronics: Design, Synthesis, and Applications
- CHEG 600 Introduction to Science and Engineering of Polymer Systems
- CHEG 818 - Scattering Methods for Soft Matter
- PHYS 661 - Data Science for Physical Scientists
- PHYS 664 - Machine Learning for Time Series Analysis

For Materials Science and Engineering, Biomedical Engineering, Chemical & Biomolecular Engineering, Chemistry & Biochemistry Students

Materials Science and Engineering Biomedical Engineering, Chemical & Biomolecular Engineering, Chemistry & Biochemistry Students must choose one of any three credits graduate elective approved in their graduate program as a **Primary Elective** course

- CHEG 600 - Introduction to Science and Engineering of Polymer Systems
- CHEG 818 - Scattering Methods for Soft Matter
- MSEG 628 - Macromolecular Design & Bioconjugations
- MSEG 631 - Organic Electronics: Design, Synthesis, and Applications
- MSEG 835 - Principles to Polymer Physics

- MSEG 817 - Composite Materials
- MSEG 660 - Biomaterials and Tissue Engineering
- CHEG 647/847 Molecular Modeling and Simulations of Soft Materials

Materials Science and Engineering Biomedical Engineering, Chemical & Biomolecular Engineering, Chemistry & Biochemistry Students must choose one of these three credits from the following restricted elective list as a **Secondary Discipline** Elective

- CHEG 647/847 Molecular Modeling and Simulations of Soft Materials
- CHEG 861 - Data Science for Chemical and Biomolecular Engineering (2 credits) & CHEG 807 - Advanced Modeling, Analysis, and Acquisition of Data (2 credits)
- CHEG 860 - Process Systems Engineering: Mathematical Modeling and Optimization Principles (2 credits) & CHEG 861 - Data Science for Chemical and Biomolecular Engineering (2 credits)
- PHYS 661 - Data Science for Physical Scientists
- PHYS 664 - Machine Learning for Time Series Analysis
- BINF 684 - Introduction to Machine Learning
- CISC684 - Introduction to Machine Learning
- ELEG 602 - Advanced Machine Learning
- CISC 882 - Natural Language Processing

2. Internship / Teaching Workshop

Graduate students will also complete a career pathway requirement by registering for UNIV 554 – Graduate Internship Semester (a zero credit course) after completion of the above course requirements.

- Students interested in pursuing industry or national lab as a career path will complete a summer internship in either industry or national lab. Duration of summer internship will be subject to student’s primary advisor’s approval but must be a minimum of two weeks. At the end of the internship, the students will be expected to complete a survey where they will share the knowledge gained and goals accomplished during the internship.
- Students interested in pursuing careers in academia will complete a summer teaching workshop. Over the course of two weeks, students will learn to articulate measurable learning outcomes, create assessments, design, and implement rubrics, develop a syllabus, and plan and deliver a classroom session. At the end of the workshop, the students will be expected to complete a survey where they will be asked to share specific teaching skills they have learned in the workshop.

○ Procedure for course substitutions

It is possible that students may need to alter approved programs of study, particularly if there are new courses that directly relate to the students’ goals and further enhance their understanding of their primary or secondary discipline. Students who wish to make changes to their program of study must request a substitution from the designated area Certificate Director and Deputy-Director and then must complete the Course Substitution form

(<https://www.udel.edu/content/dam/udelImages/grad-college/graduate-college->

[pdfs/course_substitution.pdf](#)):

For example, students may want to replace a 3-credit course with two related subject courses of 2-credits or two courses one of which is 1 credit and another related course is 2 credits; these courses should be approved graduate level electives in their department's degree program.

For any course substitution, the request must be made in writing explaining why the substitution is sought. The Certificate Director and Administrative Coordinator will consult relevant faculty members (e.g., primary advisor, course instructor) when reviewing the request and will issue a written determination for the student's record.

B. Committees for exams, thesis, or dissertations

The students enrolled in this certificate program may have their department approved committees for their qualifier exams/thesis/dissertation, however, this certificate program by itself does not have a qualifying/culminating exam, thesis or dissertation requirement.

C. Timetable and definition of satisfactory progress towards the certificate

Timeline:

The completion of this certificate is expected in less than four years. The students will be expected to complete their primary elective and secondary elective successfully at any point alongside the completion of (degree program expected) core courses in their first two years of their enrollment in their graduate program. Then after they have successfully completed the primary and secondary elective, the students are expected to complete the required course 'Computing and data science for soft materials' in Spring semester. The summer internship is expected to be completed immediately the summer after the Spring semester elective; however, in case that is not possible, then the summer internship can be completed before four years have elapsed from their enrollment date into the certificate program.

Students are expected to meet with the Administrative Coordinator at least once every semester they are in the certificate program. This is a requirement to track the students' progress of 9 course credits and professional development elements. If it is determined that the student is no longer in good academic standing (i.e. an average GPA below 3.0) or satisfactory progress is not being made in the expected course work and professional development training elements, then the Administrative Coordinator, after discussion with the student, may advise the Certificate Director to terminate the student's enrollment in the program. The student may follow the grievance procedures for the Graduate College if terminated.

Definition of satisfactory progress

Students' satisfactory progress towards the degree will be monitored through the enrolled students' UDSIS record and student updates by the Administrative Coordinator. The following define 'satisfactory progress' towards the certificate:

1. Maintaining good academic standing towards the MS/PhD degree in the student's enrolled graduate degree program
2. In all the three courses (primary elective, secondary elective, and required course), student earns a grade C or higher.
3. Successful completion of a summer internship will be evaluated via the information gathered by the Administrative Coordinator through survey of the industry mentor that the student works

closely with during the internship.

OR

Successful completion of a summer teaching workshop will be evaluated by the instructor of the teaching workshop using rubrics that measure student performance during training week and practical week.

4. Successful completion of a minimum of four professional workshops will be noted by submission of appropriate workshop documentation (e.g., certificate of completion offered by workshop, confirmation of attendance/registration, etc.) and filing by the Administrative Coordinator.

5. Summer community outreach activity completion will be decided upon submission of outreach plan and proposal.

D. Eligibility for completion

Students must have a minimum overall grade point average of 3.0 and complete all coursework and professional development training elements to receive the *Computing and Data Science for Soft Materials Certificate*.

Candidates should see that all final grades have been submitted. Students must complete the “Completion Application Form for Graduate Certificate”.

https://www.udel.edu/content/dam/udelImages/grad-college/graduatecollege-pdfs/Graduate_Certificate_Completion.pdf

Part IV. Program Educational Goals and Assessment Plan

The Graduate Certificate in *Computing and Data Science for Soft Materials* has the following program learning outcomes and assessment measures:

Learning Outcome	Measure 1 – Direct	Measure 2 -Indirect
<ul style="list-style-type: none">Identify, develop, and/or apply the appropriate type of molecular modeling and simulation and/or machine learning based tools to find answers to any given technical question in soft materials field.	<ul style="list-style-type: none">Exams, papers, and/or projects in PRIMARY AND SECONDARY ELECTIVES	<ul style="list-style-type: none">Exit Survey in coursework. This survey, consisting of short essay-type responses
<ul style="list-style-type: none">Collaborate effectively in interdisciplinary environments by	<ul style="list-style-type: none">Project oral presentations reports, group project work, final report in REQUIRED course	<ul style="list-style-type: none">Exit Survey in REQUIRED course and internship. This survey, consisting of short essay-

<p>engaging with experimentalists working in the field of soft materials or computing experts regardless of the student's own primary discipline (high performance computing/data science/soft materials/chemical sciences).</p>	<ul style="list-style-type: none"> ● Summer internship in industry 	<p>type responses or may be conducted as an interview (internship).</p>
<ul style="list-style-type: none"> ● Effectively communicate – orally and in writing – technical concepts/ideas/results to any audience regardless of their scientific background/expertise in the technical area. 	<ul style="list-style-type: none"> ● Project oral and written presentations in all three courses, research presentations in conferences ● Summer teaching workshop practical week 	<ul style="list-style-type: none"> ● Exit Survey at the end of graduate certificate program; Exit survey at the end of teaching workshop. These surveys will consist short essay-type responses.

Part VI. Financial Aid

A. Financial awards

There are no financial awards for students in the Certificate program.

Part VII. Departmental Operations

A. General student responsibilities

It is the student's responsibility to satisfy all the Certificate requirements. Students must also follow all University policies that pertain to students, to student life policies set by the University. Students in the Certificate program will not have office space nor office keys. They must have access to their own computers and printers, or use those provided in general University spaces for student use.

B. Travel for professional meetings or presentations

Students in the certificate program will not be provided travel funds for professional meetings or presentations, except for those who have received funding from the NSF NRT MIDAS award.