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Dual Degree Program:
Master of Science with a major in Data Science, and
Doctor of Philosophy in Applied Mathematics or Mathematics
University of Delaware
Program Policy Statement
Version of October 26, 2020 (approved by DMS)

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1 **Part I. Program History**

2 **A. Purpose**

3 A campus-wide Data Science Working Group (DSWG) was formed in 2016 to foster data science
4 research on the University of Delaware campus. The DSWG organized several meetings and events over
5 the course of 2017, and produced a white paper in autumn 2017. Those events, in no small part,
6 inspired the Master of Science in Data Science (MSDS) degree program. The MSDS began admitting
7 students in the fall 2018 semester, and its first students graduated in the summer of 2020. Its
8 enrollment has grown steadily, and is expected to continue to grow, in order to meet demand for the
9 skills the degree provides.

10 In 1965, the Department of Mathematical Sciences (DMS) created the seventh doctoral program hosted
11 by the university. By 1969, the department had awarded its first Ph.D. degree. Over the last forty years,
12 well over one hundred students have received doctoral degrees in Mathematics or Applied Mathematics
13 from the University of Delaware. Graduates from our program have gone on to prestigious
14 postdoctoral, academic, industrial and government positions worldwide.

15 In some respects, data science is the new collection of methods for applied mathematics in the 21st
16 century. There is a mixture of mathematics, statistics and computer science that enables new insights to
17 emerge from domains, or applications, in commerce, industry, government and academia. It is clear
18 that data science topics are taught in business, engineering and statistics as well. However, there are
19 certainly promising new areas arising in mathematics that may become methods for data science in the
20 future. This presents an opportunity to provide applied mathematics students with knowledge and
21 experience in data science that they can use to study new applications and methods. Beyond the
22 intellectual value of incorporating new topics into their studies, their career opportunities are expanded.

23 These facts motivate combining the PhD in Applied Mathematics or Mathematics (PhD) with the MSDS
24 in a dual degree program. The MSDS already allows students to take many mathematics graduate
25 courses, and the PhD program uses those courses as well. The PhD can accept two courses outside of
26 mathematics as electives, and the MSDS requirements can supply those electives. With a small number
27 of additional courses outside of mathematics, the student can satisfy the requirements for both degrees
28 if credits can be shared between the programs.

29 The PhD program may benefit from recruiting students with both mathematical and data science
30 interests, and the intellectual appeal as well as enhanced career prospects may increase the number of
31 applicants interested in earning the degree.

32 This document sets out the policies and requirements for the dual degree program combining MSDS
33 with the PhD in Mathematics or Applied Mathematics. The program uses existing degree requirements
34 for both programs, and sets out credit-sharing policies to enable the dual degree to be earned much
35 faster than earning both separately. Beyond the academic aspects, this document sets out policies for
36 administration of the program, including admissions, examinations and so forth.

37 **B. Current Status**

38 The program will begin in the fall 2021 semester. The program will be jointly administered by the MSDS
39 staff and its director(s), and the DMS staff and its Graduate Committee.

1 **C. Degree Offered**

2 This dual degree program awards an MS in data science (MSDS) combined with the PhD in either
3 Applied Mathematics or Mathematics. We use “PhD” to denote either the Applied Mathematics or
4 Mathematics PhD option. The MSDS is awarded by the Graduate College; the PhD is awarded by the
5 College of Arts and Science.

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7 **Part II. Admission**

8 **A. Admission Requirements**

9 The admission requirements are the union of those of the PhD and the MSDS. This translates to the
10 admissions requirements for the PhD plus sufficient computer science coursework to have completed
11 the equivalent of CISC 220 Data Structures. See the web pages of each of the individual degrees for
12 more information.

13 The program admission process is as follows. Completed applications consisting of the online
14 application, undergraduate/graduate transcripts, three letters of recommendation, and the written
15 statement of professional goals and values, are reviewed by the admissions committees as described
16 below. A grade point average (GPA) of at least 3.00 is preferred. Applications are evaluated based on a
17 combination of record of academic achievement, recommendations, and the applicant’s statement of
18 professional goals and values.

19

20 Three letters of recommendation from individuals familiar with the candidate’s academic and/or
21 professional background and capabilities are required. Candidates must also submit a personal
22 statement describing how their academic, professional and personal background has prepared them to
23 be successful in the MSDS+PhD program, and explaining how the completion of the MSDS+PhD will
24 contribute to their professional goals. In addition, applicants must take the GRE General Test and one
25 GRE Subject Test. It is not required that the GRE Subject Test be in mathematics.

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27 International applicants must submit official proof of English proficiency such as TOEFL or IELTS scores.
28 The successful applicant must meet the one of the following criteria:

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- Score at least 600 on the paper-based TOEFL exam.
- Score at least 100 on the TOEFL iBT, with a minimum score of 20 in each section.
- Score at least 7.5 on the IELTS with a minimum score of 6.0 in each subsection.

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33 **B. Background Requirements**

34 A Bachelor’s degree from an accredited program is required for admission. A major in any of
35 mathematics, applied mathematics, statistics, or computer science with sufficient mathematics
36 coursework is typically a good background for this program. Applicants for the MSDS+PhD dual degree
37 program must complete the background requirements prior to beginning the program (see the next
38 section and section III.A.5 for more information).

39

40 Required background for the MSDS, beyond what is required for admission to the PhD program, includes
41 at least two semesters of computer programming (including data structures or CISC220 equivalent).

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43 Additional desirable courses include

- 1 • a first numerical analysis or methods course (MATH 353 or MATH 426 or equivalent),
- 2 • an algorithms course (CISC 320 or equivalent),
- 3 • a logic and programming course (CISC 304 or equivalent),
- 4 • and both probability and statistics courses (MATH 350 and MATH 450, or STAT 470 and STAT
- 5 471, or equivalent).

6 The applicant shall apply to the PhD program in Mathematics or Applied Mathematics directly, and
7 specify that the application is for the MSDS+PhD dual degree program. The Graduate Studies
8 Committee of the DMS and Executive Committee of the MSDS will review the applications jointly; the
9 final admission decision is made by the DMS. Upon matriculation, the MSDS program will work with the
10 student and the DMS to find a course advisor for the MSDS degree who shall serve in that capacity until
11 the student selects a PhD dissertation advisor, and the student and advisors agree that the MSDS
12 advisor is no longer needed. It is expected that this will occur when the coursework is completed.

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14 Any student enrolled in the math or applied math PhD program on 15 November 2021 may apply to
15 change to the MSDS+PhD dual degree program. Students in combined bachelors and MSDS 4+1 degree
16 programs at the University of Delaware are not eligible for this dual degree program.

17 ***C. Application deadlines***

18 The application deadline for Fall admission is July 1; the deadline for Spring admission is
19 December 1. Earlier applications are encouraged because space may be limited.

20 ***D. Types of Admission***

21 Students may be admitted into the program via regular admission. Regular status is offered to students
22 who meet all of the established entrance requirements.

23 ***E. University Statement***

24 Admission to the MSDS+PhD graduate program is competitive. Those who meet the stated
25 requirements are not guaranteed admission, nor are those who fail to meet all of those requirements
26 necessarily precluded from admission if they offer appropriate strengths.

27 **Part III. Academic Degrees: MSDS+PhD dual degree**

28 Upon completion, the student will earn the MSDS and the PhD in either Applied Mathematics or
29 Mathematics. The student is awarded the MSDS and PhD simultaneously upon completion of the PhD
30 requirements and completing the appropriate forms. The PhD is awarded upon completion of all
31 requirements for that degree and completing all required paperwork. In order to satisfy the
32 requirements for the dual degree program, a total of 57 credits of coursework must be completed, while
33 satisfying the minimum GPA requirements, as detailed in the next two sections. Example courses of
34 study are given in Appendix A.

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1 **A. MSDS Degree Requirements**

2 A total of 33 credits is required for the degree as described in the program policy statement for
3 that degree. The student may apply 18 credits of MATH courses (6 credits from the required
4 list and 12 credits of electives) to both the MSDS and the PhD. Another 6 credits selected from
5 the non-MATH required courses of the MSDS may be used as electives for the PhD. This leaves
6 9 credits, including the ethics course requirement, that may only be used for the MSDS degree.

7 **B. PhD Degree Requirements**

8 A total of 48 credits of coursework must be completed for the degree, as well as all of the
9 requirements as outlined in the program policy statement for that degree. A total of 18 credits
10 of MATH courses may be applied to the MSDS degree, and two more non-MATH courses from
11 the required course list of the MSDS may be applied to the PhD degree as electives.

12 **C. Non-Thesis MSDS**

13 Only the non-thesis option for the MSDS may be used for this dual degree program.

14 **D. Bx/MSDS 4+1 Eligibility**

15 University of Delaware students in a combined bachelors and MSDS 4+1 program are not
16 eligible for the MSDS+PhD dual degree program.

17 **E. Timetable and Satisfactory Progress Toward the Degrees**

18 1) Academic load and satisfactory progress

19 The MSDS+PhD dual degree program will follow the University of Delaware, Office of Graduate and
20 Professional Education recommended policy for determining students' failure to make satisfactory
21 progress towards degree requirements and time limits for completion. Students are expected to be
22 enrolled on a full-time basis (9 credits per term). Financial aid from the DMS requires full time study.

23 2) Grade and GPA requirements

24 Students must satisfy the grade point average (GPA) requirements for the MSDS, and the GPA
25 requirements for the PhD in order to earn both degrees.

26 3) Grievance procedures

27 Students concerned that they have received an unfair evaluation or have been graded
28 inappropriately may file grievances in accordance with the student guide to University of
29 Delaware policies. Students are encouraged to contact the program director(s) prior to filing a
30 grievance.

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1 **Part IV. Assessment Plan**

2 **A. Program**

3 The program will follow the Academic Program Review (APR) schedule, policies and procedures,
 4 established by the Provost’s office and Faculty Senate. Data will be provided by the Office of
 5 Institutional Research and Effectiveness, in conjunction with faculty/student interviews,
 6 measures of scholarly productivity and feedback from alumni. Meetings will be held at least
 7 semi-annually to discuss curricular changes, review data, identify actions to strengthen the
 8 program, and establish timelines and assignments for responsibilities. The program will
 9 continue consultation with the Center for Teaching and Assessment of Learning to periodically
 10 assess learning outcomes, assessment criteria, and benchmarks for success.

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12 **B. Student Progress**

Assessment plan for students in the MSDS+PhD dual degree program				
Objectives	Strategic Activities	Measures	Short-term Outcomes	Long-term Impact
1. Train students in a mix of statistics, math and computer science	Recruit excellent applicants and matriculate students with strong credentials	Number and demographic data of student applicants and matriculated students.	Retention and time to degree statistics	Students gain employment in data-science related fields, in domain area jobs (e.g., energy, commerce, etc), or go on to more graduate school
	Course work covering the disciplines of probability, mathematics, statistics and computer programming and algorithms	Faculty evaluation of student progress in course work Surveys of graduate students in the program and post-graduation	Students are prepared for subsequent coursework that requires theoretical and practical knowledge	Graduates enjoy long term success in government, industrial, commercial or academic careers.
2. Provide training in data science techniques	Course work in regression, statistics, multivariate	Surveys of students focusing on their	Course work for the M.S. in Data Science degree helped students	Graduates enjoy long term success in data science

	analysis, logistic regression, data management, machine learning, optimization, algorithms, data mining and other approved courses including electives from domain areas	experiences in these classes Surveys of graduates to determine the utility of these classes to their career Faculty evaluation of student progress in course work	secure initial employment Students and graduates report applying knowledge from courses to work settings	and domain area careers.
3. Provide experiential training in projects or internships to prepare students for the expectations of the workplace	Case study approach in courses with real data and required analysis Research or Special Problem courses using projects from academic and non-academic sources A thesis option, when chosen, requires synthesis of the knowledge and methods studied.	Quality of the case study results in the courses. Faculty evaluation of quality and scope of the research project. Surveys of graduates to determine the utility of their course experience to their career	Case studies, Research and Special Problem courses force the student to apply the material in the class to real data. A thesis, if that option is chosen, forces the student to master an area of use to the field, and develops strong writing skills.	Graduates enjoy long term success in their careers.
4. PhD research and dissertation	Research or Special Problem courses using projects from academic and non-academic sources The PHD thesis requires synthesis of the	Faculty evaluation of quality and scope of the research project. Surveys of graduates to determine the utility of their course experience to their career	Research and Special Problem courses force the student to apply the material in the class to real data. A thesis forces the student to master an area of	Graduates enjoy long term success in their careers.

	knowledge and methods studied.		applied mathematics, and develops strong writing skills.	
5. Are graduates conducting original, high quality research within their field of specialization?	Student thesis or dissertation, student publications, and conference presentations.	Rubrics that quantify student research work for a thesis, dissertation, or conference presentation. Results are used to compare and contrast student work.		
6. Are students able to synthesize and critically analyze important issues in their field and understand and appreciate how their work fits into the larger body of science?	Student theses, oral candidacy examinations, and oral theses defenses.	Rubric used by faculty serving on thesis committees.		
7. Are students able to communicate mathematical proofs, ideas, and concepts orally?	Student evaluations of their performance as teaching assistants, oral candidacy examinations, oral theses defenses, talks in the Graduate Student Seminar, and talks at conferences.	Rubrics for oral communication used by faculty for student presentations and a teaching observation form.		

8. Are students able to communicate mathematical proofs, ideas, and concepts in writing?	Preliminary examinations, publications by students and a written thesis.	Common rubric for evaluating student writing.		
9. Are students able to demonstrate both breadth and depth of mathematical knowledge?	Results of preliminary examinations, results of oral candidacy examinations, and thesis defenses.	Rubric to evaluate preliminary examinations, candidacy examinations, and faculty feedback on these examinations.		

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2 **Part V. Financial Aid**

3 The MSDS program does not provide financial aid. The DMS and/or the University may award
4 financial aid for graduate assistantships subject to availability, and to department and
5 university policies. Financial aid awards are competitive and funds are limited.

6 **Part VI. Program Organization and Administration**

7 The MSDS program will be located in Mathematical Sciences within Ewing Hall, but will be
8 administered via the Graduate College starting in the 2021-22 academic year. The PhD is
9 administered by the DMS. The administration of the respective programs will be carried out
10 according to their respective program policy statements.

11 The program is jointly administered by the MSDS Executive Committee and the Graduate
12 Studies Committee of the DMS. This document will need approval from both programs to make
13 changes, and the work shall be shared. The MSDS director will submit proposals for
14 modification to the appropriate University systems for approval.

15 **Part VII. Appendices**

16 **A. Sample Courses of Study**

17 Some sample courses of study appear below. They are by no means exhaustive. Some
18 advanced classes may only be offered every other year. The student is strongly encouraged to
19 discuss a degree plan with her or his advisors.

20 Courses marked with a (b) are counted toward both degrees in these sample courses of study
21 (in blue text). Courses marked with an (p) are for the PhD only (also in black text); (m) marks

1 courses that are only applied to the MSDS (also in green text). We note that this is not the only
 2 possible way to arrange the courses into the three categories b, p or m.

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5 Sample Applied Mathematics Track:

Fall 1	Winter 1	Spring 1	Summer 1
MATH 600 (p)		MATH602 (p)	Project, industry or
MATH612 (b)		MATH637 (b)	research experience
MATH672 (b)		MATH611 (b)	
Fall 2	Winter 2	Spring 2	Summer 2
MATH806 (p)		MATH817 (p)	Project, industry or
MATH616 (p)		MATH617 (p)	research experience
STAT611 (b)		CISC621 (m)	
Fall 3	Winter 3	Spring 3	Summer 3
STAT613 (b)		CISC684 (m)	Math research
MATH630 (b)		MATH631 (b)	
MATH835 (p)		MATH838 (p)	
		PHIL667 (ethics)(m)	
Fall 4	Winter 4	Spring 4	Summer 4
Candidacy, research			Math research
Fall 5	Winter 4	Spring 5	Summer 5
Candidacy, research			Defend PhD dissertation

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2 Sample Mathematics track:

Fall 1	Winter 1	Spring 1	Summer 1
MATH 600 (p)		MATH602 (p)	
MATH688 (b)		MATH650 (p)	Research experience
MATH672 (b)		MATH888 (p)	
Fall 2	Winter 2	Spring 2	Summer 2
MATH630 (b)		MATH631 (b)	Project, industry or
MATH845 (p)		MATH637 (b)	research experience
STAT611 (b)		STAT613 (b)	
Fall 3	Winter 3	Spring 3	Summer 3
MATH612 (b)		CISC683 (m)	Math research
MATH850 (p)		CISC621 (m)	
MATH806 (p)		MATH611	
		PHIL667 (ethics)(m)	
Fall 4	Winter 4	Spring 4	Summer 4
Candidacy, research			Math research
Fall 5	Winter 4	Spring 5	Summer 5
Candidacy, research			Defend PhD dissertation

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