



# 2018-19 Graduate Handbook

Biomedical Data Science and Informatics (MS)

Computer Science (PhD and MS)

Human-Centered Computing (PhD)

Please see the DPA Graduate Student Handbook for the MS and MFA in DPA.

For the BDSI PhD, please see the joint Clemson-MUSC handbook.

Links to both can be found below.

August 23, 2018

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## Welcome

Welcome to the School of Computing (SOC) at Clemson University. We wish you success at every stage of your academic journey.

This handbook is intended to familiarize you, as a graduate student in the School of Computing, with the requirements and policies that govern your academic program. Any inconsistencies within this handbook or between this handbook and the Graduate School Policy Handbook should be brought to the attention of the appropriate Graduate Program Coordinator. The policies and curricula listed below are specific to the School of Computing. For Graduate School policies regarding registration, transfer credits, assistantships, and other University-wide policies, please see the Graduate School Policy Handbook.

## Graduate School Policy Handbook

The Graduate School of Clemson University publishes a handbook of policies and procedures annually, which is available at <https://www.clemson.edu/graduate/students/policies-procedures/index.html>.

## Graduate School Graduation Deadlines

The Graduate School publishes a list of deadlines for graduation, which is available at <https://www.clemson.edu/graduate/students/deadlines.html>.

## Graduate School Admissions Requirements

The Graduate School admissions requirements can be found at <https://www.clemson.edu/graduate//admissions/preparing-to-apply/supporting-materials.html>. Any additional program-specific requirements will be listed with the program.

## International Services

For policies related to International Services, please see <https://www.clemson.edu/campus-life/campus-services/international/>.

## Terminology

<b>Credit Hour</b>	<b>The semester credit hour used by Clemson University</b>
<b>Program Coordinator</b>	<b>The faculty member responsible for coordinating a degree program</b>
Dr. Mark Smotherman	Master of Science, Computer Science
Dr. Brian Dean	Master of Science, Biomedical Data Science & Informatics
	PhD, Biomedical Data Science & Informatics
	PhD, Computer Science
Dr. Eileen Kraemer	PhD, Human Centered Computing
<b>Major Advisor</b>	<b>A student's Advisory Committee Chair</b>

## Support Services

Kaley Goodwin, Administrative Assistant, [kaleyg@clemson.edu](mailto:kaleyg@clemson.edu), 864-656-5403, McAdams 105

For questions regarding student employment, registration, and room reservations

Adam Rollins, Graduate Services Coordinator, [rollin7@clermson.edu](mailto:rollin7@clermson.edu), 865-656-5853, McAdams 107

For questions regarding admissions, assistantships, and thesis and dissertation defense

## Application Deadlines

<b>Fall Semester</b>	<b>Date</b>
to be considered for a PhD fellowship	January 1
to have full consideration for an assistantship	February 1
to be considered for admission (international students)	April 15
to be considered for admission (domestic & international students already in the U.S.)	May 15
<b>Spring Semester</b>	<b>Date</b>
to have full consideration for an assistantship	September 15
to be considered for admission (international students)	September 15
to be considered for admission (domestic & international students already in the U.S.)	October 15

These are general deadlines for the School of Computing. Any program-specific deadlines will be listed under the Admissions Requirements of the program.

## Registration

The Program Coordinators are the initial advisors for all new students. Students are encouraged to consult with their Program Coordinator prior to registration, and should enroll in no more than three graduate courses during their first semester. It is possible to sit in on additional courses during the first session before deciding whether to drop or add a course. International students and students with assistantships must maintain a 9 credit hour minimum during Fall and Spring semester. Students with Summer Full Term assistantships must enroll in a minimum of 6 credit hours over the full summer term. Students with Summer I or Summer II assistantships must enroll in a minimum of 3 credit hours during the Summer I or Summer II session. Other policies regarding enrollment limits can be found in the Graduate School Policy Handbook.

For detail regarding the registration process, see <http://www.registrar.clemson.edu/html/indexRegistration.html>.

## Assistantships

Assistantships are awarded on a competitive basis to qualified students, both domestic and international. All qualified students are considered for assistantships when applications are processed; no separate applications are required. Students receiving an assistantship will receive an assistantship contract via Adobe Sign. These contracts can be signed electronically. Once signed, the student should schedule an appointment with Kaley Goodwin to complete their hiring paperwork.

## Student Employment

Students employed by the School of Computing must make an appointment with Kaley Goodwin prior to beginning their employment. During the meeting, students will learn how to track their time and set up direct deposit. Domestic students will also complete their employment verification form (I-9), and international students without a Social Security Card will learn how to apply for one. An appointment will be scheduled with Human Resources at the close of the meeting so that the student can complete the hiring process.

**YOU CANNOT BEGIN EMPLOYMENT OR RECEIVE PAY UNTIL YOU'VE BEEN THROUGH THIS PROCESS.**

Paychecks will be issued twice a month, and deposited directly into the student's bank account.

### **Social Security Card**

All employees in the United States are required to have a Social Security card (SSC). Domestic students will be asked to bring their Social Security Card to their meeting with Ms. Goodwin. International students who don't already have a Social Security Card will need to apply for one. International Employment Guidelines and the Social Security Application Procedure can be found at <http://www.clemson.edu/employment/international/>. New international students must be in the US at least 10 days before applying. We recommend that new international students arrive at Clemson 15 days before classes begin.

## Transfer Credits and Exemptions

Students with graduate credit earned at another institution, or before admission to their program, must have prior work evaluated for transfer credit. With the approval of their Major Advisor and Program Coordinator, students may transfer or exempt credits for recent graduate-level course work taken at other accredited institutions prior to admission to the program. For detail regarding the University's transfer credit policy, see the Graduate School Policy Handbook.

## MS En Route to PhD

Students who are currently enrolled in a PhD program and who have completed or plan to complete all requirements for an MS in the same discipline can apply for an MS en route. These students are expected to continue in the PhD program after receiving the MS degree. Students interested in an MS en route should discuss the MS requirements with the MS Program Coordinator.

## MS Thesis and PhD Advisory Committees

The Program Coordinator is the initial advisor for all new graduate students within their program, and will serve as advisor until the student identifies an Advisory Committee. To select a committee, the student will first select a Major Advisor, who will assist the student in identifying the remaining members, and who will act as the student's Advisory Committee Chair. The Major Advisor must be a full-time faculty member at Clemson who is tenure track and has at least a 51% appointment in the School of Computing.

For PhD students, the Advisory Committee must be composed of 4 faculty members, including the Major Advisor. The student will select two of those faculty members in consultation with his or her Major Advisor, and at least one of those two must have an SOC appointment. The final committee member will be selected by the Program Coordinator, and will serve during the proposal and dissertation phases to make sure the student is following SOC procedure. For MS students, the Advisory Committee must be composed of three faculty members, including the Major Advisor. The student will select a second committee member in

consultation with his or her Major Advisor. It is not required that the second member have a School of Computing appointment. The third committee member will be selected by the Program Coordinator, and will serve during the proposal and dissertation phases to make sure the student is following SOC procedure. A step-by-step summary of the committee selection can be found below:

1	The student selects a Major Advisor.
2	The student consults with his or her Major Advisor in the selection of additional committee members.
3	The student contacts the Program Coordinator to identify the final committee member.
4	The student submits the committee selection using the online GS2

An Advisory Committee should be selected during the student’s first year. Directions and filing deadlines for the GS2-Committee Selection can be found at <https://www.clemson.edu/graduate/students/plan-of-study/index.html>. Once the committee is finalized, it will assist the student in selecting courses, approve the student’s course selection, approve the dissertation proposal, and evaluate the dissertation defense.

Selection of the student’s committee members, including the Major Advisor, requires the mutual consent of the student and the faculty selected. A student is free to dissolve an existing committee and form a new one at any time. Similarly, the Major Advisor is free to step down as Advisor, and committee members to leave the committee, if research interests change or relationships prove to be incompatible.

## MS Non-thesis Advisory Committee

Coursework-only students are assigned an Advisory Committee from the members of the Graduate Affairs Committee. The composition of this committee changes from year to year. For the current academic year, MS non-thesis students should list Dr. Mark Smotherman as their chair, and Drs. Eileen Kraemer and Victor Zordan as their additional committee members.

## The Graduate Plan of Study (GS2 Course Selection)

The student’s graduate degree curriculum will be selected in consultation with his or her Major Advisor, and documented by filing a GS2 Plan of Study. The student’s curriculum may be revised as necessary by submitting a new GS2.

Directions and filing deadlines for the GS2 Course Selection can be found at <https://www.clemson.edu/graduate/students/plan-of-study/index.html>.

## PhD Research

We encourage PhD students to involve themselves in research under the supervision of a faculty member at the earliest possible opportunity. Coursework leading to the Doctorate of Philosophy is designed to give students a comprehensive knowledge of their field of specialization and a mastery of the methods of research. The degree is not awarded solely on the basis of coursework completed, residence, or other routine requirements. The final basis of granting the degree is a student’s grasp of a broad field of study, competence in planning and conducting research, and ability to adequately express the results of research in both spoken and written language.

## The PhD Portfolio

To be admitted to Ph.D. candidacy, a student must pass a comprehensive examination. The form of this examination is a portfolio review that is performed by program faculty. The review is intended to certify competency in the student's core areas of study, demonstrate potential for research, and promote scholarly and professional skill.

Students are given at most two opportunities to pass this exam. A student who is denied admission to candidacy after the first attempt may, at the discretion of faculty, be given one additional chance to correct the identified deficiencies. Graduate School policy requires that a student who fails his or her comprehensive examination a second time be dismissed from the graduate program.

The student is solely responsible for the contents of the portfolio, and it is important to begin the preparation of the portfolio early, in consultation with the student's Major Advisor. Students entering with an MS must submit their portfolio before the beginning of their fourth semester; students entering without an MS, before the beginning of their sixth.

The Coordinator of the student's program will initiate the call for portfolio submission. For program-specific portfolio requirements, see Programs of Study.

## The PhD Dissertation Proposal

The dissertation proposal serves several purposes. It ensures that the student has a clear grasp of a specific problem or set of problems; it provides a format for discussion of the solutions or approaches to solving the problem(s); and it provides documentation that the student has undertaken a reasonable survey of the literature related to his or her research.

The proposal itself is presented to the student's Advisory Committee. The purpose of the proposal is to inform the committee of the nature and scope of the proposed dissertation and to obtain their approval and guidance concerning the proposed research. The written proposal should include the following items:

- an outline of the included material
- a concise review of the state of knowledge in the general area of interest
- a description of the proposed dissertation area, along with a concise review of the state of knowledge in the specific area of the proposed dissertation
- a concise explanation of the problem(s) to be investigated
- a discussion of the results expected from solving the problem(s) and their impact on the state of knowledge in the general and specific areas of interest
- a bibliography

The written proposal must be presented publicly, and approved by the student's Advisory Committee. The presentation must be scheduled in consultation with the Advisory Committee, and the written document must be available to the Committee at least two weeks before the presentation occurs. The Advisory Committee will be asked to give written approval of the proposal after the presentation, and that approval will be based primarily on the written document. If the proposal is not approved, it may be repeated an indefinite number of times, subject to the consent of the Committee, but the proposal must be approved at least six months prior to the completion of the dissertation.

Students can schedule their presentation by submitting the following form:

[https://www.clemson.edu/cecas/departments/computing/resources/faculty\\_resources/MS%20PhD%20Presentation%20Scheduling%20Form.pdf](https://www.clemson.edu/cecas/departments/computing/resources/faculty_resources/MS%20PhD%20Presentation%20Scheduling%20Form.pdf).

A step-by-step summary of the proposal process can be found below:

1	Submit written proposal to Advisory Committee at least two weeks prior to expected presentation date.
2	Schedule a presentation date in consultation with Advisory Committee.
3	Submit scheduling form to Adam Rollins, McAdams 107.

## The PhD Dissertation

The research requirement is the most important aspect of PhD study. The doctoral dissertation is the written record of the research that the student has conducted and must provide evidence of the student's ability to independently perform original research leading to the discovery of new and significant knowledge. The dissertation should demonstrate the student's technical mastery of the subject, independent scholarly work, and conclusions that modify or enlarge previously existing knowledge. The dissertation is expected to:

- Identify a significant open question or problem in the student's field of study
- Describe the current state of knowledge of the area(s) involved
- Present a solution or solutions to the problem identified
- Report on the results of the research conducted, substantiate those results, and demonstrate their originality and contribution

The format of the dissertation must conform to the current SOC and Graduate School standards. Copies of the dissertation must be delivered to the student's Advisory Committee at least two weeks prior to the final oral examination.

## The PhD Dissertation Defense

PhD students will present a summary of their dissertation at a School of Computing colloquium. This presentation must include an explanation of the problem(s) addressed, a description of the results, and an explanation of their significance. After the presentation, a brief period may be allocated for questions from the general audience. At the end of the general Q&A, the Final Doctoral Oral Examination will be conducted by the student's Advisory Committee. Members of the faculty, as well as members of GAC and the Dean of the Graduate School are invited to attend the examination. The final examination demands a broad and penetrating interpretation by the student of the research project and its conclusions. It may also include examination of the student in the major and minor fields of specialization. A student who fails the final oral examination may be allowed a second opportunity, if recommended by the Advisory Committee. Failure of the second examination will result in dismissal from the Graduate School. The Advisory Committee will submit written approval to the Graduate School upon successful completion of the defense.

The dissertation defense should be scheduled following the same procedure as the dissertation proposal.

## The PhD Publication requirement

Prior to graduation, each PhD student must publish, or have accepted for publication, results of the research related to their dissertation. The paper must be fully refereed, and either published in a peer-reviewed journal or accepted in the proceedings of a conference. The paper may be co-authored with the student's Major Advisor.

## Programs of Study

### Biomedical Data Science & Informatics, Doctorate

Program Coordinator: Dr. Brian Dean, [bcdean@clemson.edu](mailto:bcdean@clemson.edu), 205 McAdams Hall

For program details for the Doctorate in Biomedical Data Science & Informatics, please see <https://www.cs.clemson.edu/bdsi/>.

### Biomedical Data Science & Informatics, Master of Science

Program Coordinator: Dr. Brian Dean, [bcdean@clemson.edu](mailto:bcdean@clemson.edu), 205 McAdams Hall

#### Overview of Program

The BDSI-MS is an interdisciplinary program that leverages the broad strengths of a Tier 1 Research University, spanning the fields of computing, engineering, mathematics, biology, and public health. The objective of the program is to produce the next generation of data scientists, prepared to manage and analyze big data sources from mobile sensors to genomic and imaging technologies. Graduates will possess the necessary skills for informatics careers in biology, medicine, and public health, with a focus on the development of prescriptive analytics derived from large fields of data.

Graduates of the program will be able to:

1. Manage and analyze data, developing prescriptive analytics from large data sets.
2. Apply technological approaches in a biomedical context.
3. Identify the principles and limitations of public health programs as they relate to epidemiological problems.

Courses can be taken at The Medical University of South Carolina, the University Center of Greenville, and the Zucker Family Graduate Education Center at CURI campus, North Charleston, in addition to the courses offered at Clemson's main campus.

Typical time to completion is two years. The program is not available online.

#### Admission Requirements

The BDSI-MS program is designed for students with undergraduate computer science, math, engineering, or biomedical sciences experience who wish to make a contribution to biomedical sciences and individual and societal health. Admission requirements include:

- A bachelor's degree in biomedical or health sciences, computing, mathematics, statistics, engineering, or related discipline
- The General GRE
- One year of calculus
- One year of college biology

- Computer programming coursework (e.g., at least one advanced programming course) or substantial experience in industry

The following experiences are recommended, but not required:

- Competency in a second area—biomedical or health sciences, computing, mathematics, statistics, or engineering— beyond the bachelor’s degree, as demonstrated by completion of a major, minor or certificate
- Relevant research or work experience
- Coursework in multivariate calculus, linear algebra, probability and statistics, and biostatistics
- One year of computer science coursework that focuses on the fundamentals of computer science and software engineering principles, including abstraction, modularity, and object-oriented programming

The annual deadline for complete applications is April 15.

### Degree Requirements

Each student will work with the Program Coordinator to construct a program of study that conforms to the following 32-34 hour requirement:

- Area I – Biomedical Informatics Foundations and Applications (12 hours)
- Area II – Computing/Math/Stats/Engineering (12 hours)
- Area III – Health Systems, Quality, and Safety (5-6 hours)
- Area IV – Domain Biology/Medicine (3-4 hours)

In cases where the student comes to the program with prior coursework in a required area, the Program Coordinator may approve a substitution. In cases where a student lacks pre-requisites for a required course, the student will be asked to complete both the pre-requisite coursework and the required course.

### Coursework

Area I: Biomedical Informatics Foundations and Applications (12 Credits)

Research Foundations (3 credits)—select one of the following:
Applied Statistical and Research Methods 3 Credits (MUSC course)
Applied Research 3 Credits (MUSC course)
HLTH 8210 - Health Research I: Design and Measurement 3 Credits

Biomedical Informatics Foundations (6 credits):
Introduction to Biomedical Informatics 3 Credits (MUSC course)
Biomedical Data Standards and Ontology 3 Credits (MUSC course)

Track Specific Core Course (3 credits)—select one of the following:
Precision Medicine Informatics 3 Credits (MUSC course)

Population Health Informatics 3 Credits (MUSC course)
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Clinical and Translational Informatics 3 Credits (MUSC course)
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Area II: Computing, Mathematics, Statistics and Engineering (12 Credits)

Mathematical and Computing Foundations (3 Credits)—select one of the following:
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Mathematical Methods in Biomedical Imaging 3 Credits (MUSC course)
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MATH 8050 - Data Analysis 3 Credits
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STAT 8010 - Statistical Methods I 4 Credits
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Data Science (6 credits)—select one course from Machine Learning/Data Science, and one course from either Biostatistics; Data Mining; Visualization and Exploratory Data Analysis; Image Processing; Decision Analysis; Knowledge Integration and Modeling; Geospatial Analysis; Algorithms and Data Structures; or Natural Language Processing
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Machine Learning/Data Science
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Machine Learning 3 Credits (MUSC course)
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CPSC 6300 - Data Science 3 Credits
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CPSC 8100 - Introduction to Artificial Intelligence 3 Credits
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Biostatistics
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Introduction to Clinical Biostatistics (Biostatistics I) 3 Credits (MUSC course)
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Biostatistical Methods II 3 Credits (MUSC course)
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HLTH 8310 - Quantitative Analysis in Health Research I 3 Credits
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STAT 8190 - Biostatistics 3 Credits
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Data Mining
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Bayesian Biostatistics 3 Credits (MUSC course)
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CPSC 8480 - Network Science 3 Credits
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CPSC 8650 - Data Mining 3 Credits
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ECE 8560 - Pattern Recognition 3 Credits
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MATH 8070 - Applied Multivariate Analysis 3 Credits
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Visualization and Exploratory Data Analysis
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CPSC 8040 - Data Visualization 3 Credits
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CPSC 8810 - Selected Topics 1-3 Credits
Image Processing
Signal and Image Processing 3 Credits (MUSC course)
BIOE 6310 - Medical Imaging 3 Credits
ECE 6310 – Introduction to Computer Vision 3 Credits
ECE 8470 - Digital Image Processing 3 Credits
ECE 8770 - Computer Vision 3 Credits
Decision Analysis, Knowledge Integration and Modeling
ECE 6420 - Knowledge Engineering 3 Credits
IE 8030 - Engineering Optimization and Applications 3 Credits
IE 8520 - Prescriptive Analytics 3 Credits
MATH 6410 - Introduction to Stochastic Models 3 Credits
Geospatial Analysis
GIS and Mapping for Public Health 3 Credits (MUSC course)
PADM 8420 - Geographic Information Systems for Public Administrators 3 Credits
Algorithms and Data Structures
CPSC 8380 - Advanced Data Structures 3 Credits
CPSC 8400 - Design and Analysis of Algorithms 3 Credits
Natural Language Processing
Natural Language Processing 3 Credits (MUSC course)
Systems and Data Management (3 Credits)— select one of the following:
Database Management 3 Credits (MUSC course)
CPSC 8710 - Foundations of Software Engineering 3 Credits
CPSC 8620 - Database Management System Design 3 Credits
CPSC 8300 - Systems Modeling 3 Credits
CPSC 8470 - Introduction to Information Retrieval 3 Credits
CPSC 8200 - Parallel Architecture 3 Credits
CPSC 6550 - Computational Science 3 Credits
CPSC 6620 - Database Management Systems 3 Credits

CPSC/ECE 6780 - General Purpose Computation on Graphical Processing Units 3 Credits
CPSC 6140 - Human and Computer Interaction 3 Credits
CPSC 8490 – Principles of Scientific Computing 3 Credits
ECE 6730 - Introduction to Parallel Systems 3 Credits
ECE 8750 - Peer to Peer Wireless and Cloud Computing 3 Credits
HCC 8310 - Fundamentals of Human-Centered Computing 3 Credits
IE 6880 - Human Factors Engineering 3 Credits
IE 8000 - Human Factors Engineering 3 Credits

Area III: Population Health, Health Systems and Policy (5-6 Credits)

Select two of the following
Ethical, Legal and Regulatory Issues in Health Informatics 3 Credits (MUSC course)
Foundations of Epidemiology I 3 Credits (MUSC course)
Foundations of Epidemiology II 3 Credits (MUSC course)
Health Law and Risk Management 3 Credits (MUSC course)
Health Policy 3 Credits (MUSC course)
Quality Management of Health Care Services 3 Credits (MUSC course)
HLTH 8900 - Selected Topics in Health Research and Evaluation 3 Credits
HLTH 8100 - Health Policy 3 Credits
HLTH 8110 - Health Care Delivery Systems 3 Credits
HLTH 8130 - Population Health and Research 2 Credits
HLTH 8140 - Health System Quality Improvement 2 Credits
HLTH 8020 - Health Economics 3 Credits

Area IV: Biological/Medical Domain (3-4 Credits)

Select one of the following
Foundations of Biomedical Sciences I 4 Credits (MUSC course)
Foundations of Biomedical Sciences II 4 Credits (MUSC course)
BCHM 6360 - Molecular Biology: Genes to Proteins 3 Credits

BCHM 6430 - Molecular Basis of Disease 3 Credits
BIOE 8460 - Biomedical Basis for Engineered Replacement 3 Credits
BIOL 6030 - Introduction to Applied Genomics 3 Credits
GEN 6700 - Human Genetics 3 Credits

### Combined Bachelor's/Master's

The BDSI-MS offers several combined BS-MS course plans. Partner departments include Bioengineering, Computer Science, Computer Engineering, and Mathematics. These course plans allow Clemson undergraduates to apply up to 12 hours of graduate coursework to both their BS and MS degrees.

To qualify for a combined BS/MS course plan, students are required to have a minimum 3.4 GPA, and to have completed at least 90 credit hours upon entry.

## Computer Science, Doctorate

Program Coordinator: Dr. Brian Dean, bcdean@clemson.edu, 205 McAdams Hall

### Overview of Program

The objective of this program is to prepare exceptionally qualified individuals for research careers in academia and industry. The PhD degree is viewed as a certification by the faculty that the student has a solid foundation in computer science and has performed original research in the area.

Graduates of the program will be able to:

1. Draw on a broad background of computing knowledge to address advanced computing problems.
2. Be able to perform original research, including formulation of problems and solutions, implementation and analysis, and communication of results.
3. Possess the skills necessary to sustain successful careers and leadership roles in both academia and industry.

PhD in CS students may study in either Clemson, at McAdams Hall, or in Charleston, at the Zucker Family Graduate Education Center.

Because the curriculum will be tailored to each student, the time needed to complete the degree will vary, but in general, it is expected that students can complete the degree in five years or less.

The program cannot be completed online.

### Admission Requirements

The program is designed for students who offer evidence of exceptional scholastic ability, intellectual creativity, and research motivation. The expected background includes:

- Programming (CPSC 1010 and 1020)
- Discrete math (CPSC 2070)
- Data structures (CPSC 2120)
- Computer organization (CPSC 2310)
- Operating Systems (CPSC 3220)

- Programming systems and paradigms (CPSC 3520)
- Algorithm analysis and theory (CPSC 3120 or CPSC 3500)

Admission is available for both fall and spring semesters. The GRE exam is required, but there are no other program-specific materials required as part of the application.

### Degree Requirements

The PhD in Computer Science includes coursework requirements, a portfolio examination, a written dissertation—which includes a proposal and defense—and a publication requirement. Program-specific coursework and portfolio requirements can be found below. For information on dissertation and publication requirements, see pages 5-7.

### Coursework Requirements

Coursework requirements for the PhD vary depending on whether the student enters with a BS or MS degree, and whether the student plans to earn an MS degree en route. Courses are intended to demonstrate breadth in computer science as well as experience in research. All PhD students are required to complete:

- 1 credit of Introduction to Faculty Research (a CPSC 9500 offered in your first semester),
- 3 credits of Research Experience (typically in your second semester as CPSC 8880 or CPSC 9500 credits),
- at least 6 additional credits of PhD seminar courses (CPSC 9500),
- 18 credits of doctoral research (CPSC 9910), and
- 2 additional credit hours for students entering with a BS, to meet the University’s credit-hour minimum

In addition to the requirements above, students must meet the minimum credit hours for graded coursework as defined by the University, as well as satisfy the requirements for the PhD Portfolio’s demonstration of core competencies. The minimum credit hours as defined by the University are listed in the table below:

Beginning Degree	Degree(s) Earning	University Minimum	Total Credits (including CPSC requirements)
MS	PhD	12	40
BS	PhD (direct entry)	30	60
BS	PhD + MS en route	42	70

The required 12 credit hours of coursework beyond the Master’s degree may be satisfied by taking four 8000-level courses within the School of Computing (exclusive of 8810, 95x0, 9810, 9910, and any DPA prefix). One 3-credit 8000-level course not meeting these restrictions may be included in the 12 credit hours with the approval of both the student’s Major Advisor and the Program Coordinator.

For students entering with a BS, up to 6 credit hours of 6000-level coursework at Clemson may be counted toward the minimum 30 credit hours required by the University. Up to 6 credit hours of 8810 may also be counted.

The core competency requirements are outlined in the following section.

## PhD Portfolio Requirements

To pass the portfolio review for the PhD in Computer Science, students must demonstrate superior mastery in four of seven core areas of computer science. A grade of A in each chosen core course or a strong letter of support from each instructor is expected. Up to two of these courses may come from another university, in which case the approval of the Program Coordinator is required. Another mechanism for demonstrating mastery includes a strong research publication record in a given area. The core areas are identified as follows:

PhD Core Areas	Courses
Algorithm and Theory	8380, 8390, 8400
Graphics and Visualization	8050, 8170, 8190
Computer Networks	8510, 8520, 8530
Information Management	8620, 8630, 8650
Languages and Translators	8270, 8280, 8290
Software Engineering	8720, 8730, 8750
Systems	8200, 8220, 8240, 8550

One course should be selected from each of four core areas. At least one of the four selected core courses must be from the Formal Thinking course group, which consists of 8280, 8380, 8390, 8400 and 8730. At least one of the four selected core courses must be from the Implementation course group, which consists of 8050, 8170, 8190, 8220, 8270, 8290, 8520, 8530, 8550, 8620, and 8650.

Students must also demonstrate potential for research. A research paper in which a significant component of the writing was done by the candidate must be included. The paper should be of sufficient quality to indicate that the student has the ability to conduct original research and make an acceptable written presentation of the results. Although not required, students are strongly encouraged to submit the paper to a conference or workshop. For such submissions, the student may be the sole author or may be a co-author with other faculty and/or other students. However, if the paper has joint authorship, the other authors must submit written documentation identifying those sections of the paper that were written by the candidate. The paper does not have to be accepted or published to be included in a successful portfolio. Although a published paper provides more convincing evidence for research potential, a rejected submission, along with peer reviews, can also be used to evaluate potential. The paper may or may not be related to the student's eventual dissertation area. A candidate's MS research paper, thesis, or a derivative thereof may be used to satisfy this requirement.

Additionally, the student must provide:

- a statement of purpose
- a brief curriculum vitae
- two supporting letters of recommendation from School of Computing faculty

Optional material may be included at the discretion of the student, and in consultation with the student's Major Advisor. This material may include:

- Significant accomplishments - An informal statement of the two or three things that the student is most proud of in this period. Examples include earning an "A" in a difficult course, finishing an M.S. research paper, or having a peer-reviewed paper accepted.
- Honors and Awards - Awards of competitive fellowships and induction into honor societies.
- Presentations - Typical categories include seminars, professional presentations, and tutorials. Workshop, class, and conference presentations may be included.
- Proposals in preparation, in review, and accepted - Include fellowship applications, grant applications, applications to industrial affiliates, requests for travel money from conference organizers, etc. Note the status of the proposal: in preparation, under review, accepted, rejected, or under revision.
- Professional Reviewing - Include reviewing for journals, conferences, workshops, and book prospecti. Significant internal reviewing may also be included; for example, if more than a few hours were spent reviewing drafts of papers or proposals for faculty members.
- Service - Include University and SOC service other than research and teaching. Examples include service on standing and ad hoc SOC committees or as a graduate student representative.

## Computer Science, Master of Science

Program Coordinator: Dr. Mark Smotherman, [mark@clemson.edu](mailto:mark@clemson.edu), 108 McAdams Hall

### Overview of Program

The Master of Science program in Computer Science prepares individuals for a PhD program, research careers in industry, or advanced technical positions in industry and government.

Graduates will be able to:

1. Frame a real-world problem such that it can be addressed computationally.
2. Evaluate multiple computational approaches to a problem and choose the most effective one. The different approaches may involve different algorithms and/or different software tools.
3. Apply reasoning and technical skills to solve a computational problem with minimal guidance.

Completion of the MS program normally requires from one and one-half years to two years beyond the undergraduate degree, but may require additional time for students whose undergraduate degree is in an area other than computer science. For students receiving assistantships, two academic years are usually required for the completion of the degree.

Courses are available in both Clemson and Charleston. The program cannot be completed online.

### Admission Requirements

The MS program is designed for students who already have a background in computer science and who offer evidence of above average scholastic ability at the undergraduate level. The expected background includes:

- Programming (CPSC 1010 and 1020)
- Discrete math (CPSC 2070)
- Data structures (CPSC 2120)
- Computer organization (CPSC 2310)
- Operating systems (CPSC 3220)
- Programming systems and paradigms (CPSC 3520)

- Algorithm analysis or theory (CPSC 3120 or CPSC 3500)

Students without a computer science background can apply as second baccalaureate students in order to take prerequisite courses. In some cases, students can take CPSC 8270 and either 8390 or 8400 to satisfy the final two areas listed above while also applying these graduate courses toward the master’s degree.

Admission is available for both fall and spring semesters. The General GRE exam is required, but there are no other program-specific materials required as part of the application.

### Degree Requirements

The requirements for the M.S. are based on 30 credits, which may be obtained through either:

- 30 credits of coursework
- 24 credits of coursework and 6 credits of MS thesis research (CPSC 8910).

**The Coursework-Only Option:** In this option, a student is required to complete ten approved courses. There is no thesis presentation or comprehensive examination required for the degree.

**The Thesis Option:** The thesis option is designed for students who have a strong interest in research and who can complete an original and creative research project. The quality of the research and presentation should be such that the thesis or a derivative work is acceptable for publication in a refereed conference proceeding or archival journal.

The final examination is an oral examination conducted by the student's Advisory Committee. The student is expected to demonstrate an in-depth understanding of both the research results presented and the pre-existing body of knowledge that the results extend.

Of the 30 credits required for graduation, the student must have 6 credits of CPSC 8910. The student must also meet the Concentration and Breadth Requirements as defined below in the remaining 24 credits of coursework. A student may take more than six credits of CPSC 8910, but only six credits may be applied toward the degree.

**6000/8000-Level Credits:** At least 21 of the 30 credits must be at the 8000 level for the coursework-only option, and at least 24 of the 30 credits must be at the 8000 level for the thesis option. The 24 credits for the thesis option include 6 credits for 8910, so 18 credits of 8000-level courses are needed.

**Concentration and Breadth:** During the MS program, the student will choose a concentration of study in one of six core areas and will choose courses in at least three other core areas for breadth.

**Concentration Requirement:** Each student must take at least three courses in one core area. These courses can be selected from the courses listed in the table below or from approved CPSC 8810 special topics courses in that area.

**Breadth Requirement:** Each student must take one course in at least three other core areas. The core areas are listed below:

MS Core Area	Courses
Computing Foundations	8280, 8380, 8390, 8400, 8480, 9400

Graphics and Visualization	6040, 6050, 6110*, 6160*, 8040, 8050, 8110, 8170, 8190
Informatics and Scientific Computation	6300, 6550, 6620, 6630, 8100, 8450, 8470, 8490, 8620, 8630, 8650, 8770
Interactive Computing	6110*, 6120, 6140, 6150, 6160*, 6180, HCC 8310, HCC 8330
Software Engineering	6160*, 6720, 8700, 8710, 8720, 8730, 8750
Systems and Implementation	6200, 6240, 6280, 6770, 6780, 8200, 8220, 8240, 8270, 8290, 8300, 8510, 8520, 8530, 8540, 8550, 8570, 8580

\* CPSC 6110 and 6160 span core areas but will count in only one core area each

**Transfer Credits:** Students in either the course-work only or thesis options may include up to 6 credits of approved courses from outside the School of Computing.<sup>1</sup> The 6 credits of approved courses may include courses transferred from another university, and these courses will be listed as CPSC 6999 or 8999 on the GS2.

**Course Exclusions:** Of the 30 credits of approved courses required for graduation, the student may not include credit for CPSC 6810, 6890, 8880, or 9500, or DPA 6000-6030, 6810-6830, 8600, or 8800. Additionally, only six credits of CPSC 6820 or CPSC/HCC 8810 can be included.

### The MS Thesis Defense

The defense should be scheduled in concert with the student's Advisory Committee, and the following form submitted to the Graduate Services Coordinator:

[https://www.clemson.edu/cecas/departments/computing/resources/faculty\\_resources/MS%20PhD%20Pr es. entation%20Scheduling%20Form.pdf](https://www.clemson.edu/cecas/departments/computing/resources/faculty_resources/MS%20PhD%20Pr es. entation%20Scheduling%20Form.pdf).

### Combined Bachelor's/Master's

A combined BS/MS in Computer Science is available. The complete BS/MS process will typically take five and a half years. The School of Computing currently allows up to nine credit hours to count toward the requirements of both degrees.

To qualify for a combined BS/MS course plan, students are required to have a minimum 3.4 GPA, and to have completed at least 90 credit hours upon entry. Interested students should contact the MS Computer Science Program Coordinator during the spring semester of their junior year.

## Digital Production Arts, Master of Fine Arts

Program Coordinator: Dr. Victor Zordan, [vbz@clemson.edu](mailto:vbz@clemson.edu), 308 McAdams Hall

For program details for the Master of Fine Arts in Digital Production Arts, please see <https://www.cs.clemson.edu/dpa/>.

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<sup>1</sup> Students from the University of Science and Technology in China (USTC) may include up to 10 credits of approved transfer courses from USTC.

## Digital Production Arts, Master of Science

Program Coordinator: Dr. Victor Zordan, [vbz@clermson.edu](mailto:vbz@clermson.edu), 308 McAdams Hall

For program details for the Master of Science in Digital Production Arts, please see <https://www.cs.clemson.edu/dpa/>.

## Human-Centered Computing, Doctorate

Program Coordinator: Dr. Eileen Kraemer, [etkraem@clermson.edu](mailto:etkraem@clermson.edu), 312 McAdams Hall

### Overview of Program

The objective of the PhD in Human-Centered Computing is to prepare our graduates for advanced research positions in industry and the academy. The program is designed for students who offer evidence of exceptional scholastic ability, intellectual creativity, and research motivation. The HCC PhD degree is viewed as a certification by the faculty that the student has a solid foundation in human-centered computing and has performed original research in the area.

Graduates of the program:

1. Will possess a deep knowledge of computing, people, and research methods, as well as a cognate or specialty area.
2. Will have extended, by way of innovative research, the frontier of knowledge in at least one area of computing as it relates to a human condition or concern.
3. Will be able to express ideas adequately and professionally in spoken and written language.

The HCC PhD program will typically require two to four years beyond the MS degree, and includes opportunities for interdisciplinary and interdepartmental research.

This program cannot be completed online.

### Requirements for Degree

The PhD in Human-Centered Computing includes coursework requirements, a portfolio examination, a written dissertation—which includes a proposal and defense—and a publication requirement. Program-specific coursework and portfolio requirements can be found below. For information on dissertation and publication requirements, see pages 5-7.

### Coursework and Seminar Requirements

The requirements for the PhD in Human-Centered Computing include:

Coursework	Credits
Fundamentals of HCC	3 credits
Graduate Level Computer Science Courses	12 credits
Courses in People/Human Condition/HCI	6 credits
Research Methods courses	6 credits
Cognate or Specialty Area Approved by Advisor	9 credits

<b>Research</b>	<b>Credits</b>
Pre-dissertation Research (pre-portfolio, HCC 8880)	6 credits
<b>Dissertation Research</b>	<b>Credits</b>
Dissertation Research	18 credits

### **Entering With or Without a Master's Degree**

At least 12 credits of coursework beyond the Master's Degree must be taken at Clemson. There is also an option for direct-entry students without an MS to obtain a Master's degree en route to the HCC PhD Please see the HCC Program Coordinator for detail.

### **Seminars**

Full-time students in the HCC PhD program are encouraged to take one seminar (HCC/CPSC 95x0 /9810) per semester until passing the comprehensive exam, and one per year until completion of the program.

### **PhD Portfolio Requirements**

- Transcripts – the minimum GPA is 3.5
- Writing Sample – A research paper in which a significant component of the writing was done by the candidate must be included. The paper should be of sufficient quality to indicate that the student has the ability to conduct original research and make an acceptable written presentation of the results. Although not required, students are strongly encouraged to submit the paper to a conference or workshop. For such submissions, the student may be the sole author or may be the first co-author with other faculty and/or students. If the paper has joint authorship, the other authors must submit written documentation identifying those sections of the paper that were written by the candidate. The paper does not have to be accepted or published to be included in a successful portfolio. Although a published paper provides more convincing evidence for research potential, a rejected submission, along with peer reviews, can also be used by the Graduate Affairs Committee to evaluate potential. The paper may or may not be related to the student's eventual dissertation. A candidate's MS research paper, thesis, or a derivative thereof may be used to satisfy this requirement.
- Statement of Purpose – A one page description of research interests and intended topics of study.
- Plan of Study – The plan of study should be consistent with the student's statement of purpose and include a list of courses the student has taken or plans to take.
- Major Advisor's Letter of Support – The portfolio should be submitted under the direction of the student's advisor, with the advisor providing a letter of support.
- Student Curriculum Vitae.