COMPUTATIONAL AND DATA SCIENCES (CDS)

100 Level Courses

CDS 101: *Introduction to Computational and Data Sciences.* 3 credits.
Introduction to the use of computers in scientific discovery through simulations and data analysis. Covers historical development and current trends in the field. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Mason Core: Mason Core, Natural Science Overview (https://catalog.gmu.edu/mason-core/)

Recommended Prerequisite: Appropriate score on the math placement test.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 102: *Introduction to Computational and Data Sciences Lab.* 1 credit.
Experiments in computational and data sciences explore the connections between on-going advances in the natural sciences and the rapid advances in computing and data handling. Lab exercises demonstrate the use of computers in analyzing data, in modeling science problems, and in creating numerical simulations across the science disciplines. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Mason Core: Mason Core, Natural Science with Lab (https://catalog.gmu.edu/mason-core/)

Recommended Prerequisite: CDS 101. Concurrent enrollment is permitted.

Schedule Type: Laboratory

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 130: *Computing for Scientists.* 3 credits.
Covers use of computers to solve practical scientific problems. Topics include creating effective scientific presentations, analysis of experimental data, online literature, data/information ethics, scientific modeling, and communication/collaboration tools. Designed to equip students with the knowledge and confidence they need to use future hardware and software systems both as students and throughout their scientific careers. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Mason Core: Mason Core, Info Tech & Computing (https://catalog.gmu.edu/mason-core/)

Recommended Prerequisite: Passing score on the math placement test for MATH 113.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 151: *Data Ethics in an Information Society.* 1 credit.
Examination of ethical issues related to access and use of information and data in the Internet age, for the general student, with special emphasis on ethical issues that apply to the proper use and interpretation of scientific and technical information. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

200 Level Courses

CDS 201: *Introduction to Computational Social Science.* 3 credits.
Undergraduate-level introduction to computational concepts, principles, and modeling approaches in social sciences, emphasizing simulations and elements of complexity theory as they apply to social phenomena. Survey includes systems dynamics, cellular automata, and agent-based models. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 205: *Introduction to Agent-based Modeling and Simulation.* 3 credits.
Undergraduate-level introduction to Agent-based Modeling. Provides a background onto why agent-based models and hands-on examination of agent-based models in the social sciences by examining and experimenting with a variety of social simulation projects. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 230: *Modeling and Simulation I.* 3 credits.
This course expands upon the foundation provided by CDS 130. Fundamental computational modeling techniques are used in a variety of science and engineering disciplines. Continued development of algorithmic thinking skills will be done using different computational environments. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Recommended Prerequisite: CDS 130 or permission of instructor.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 251: *Introduction to Scientific Programming.* 3 credits.
Focuses on elements of programming using the Fortran language and selected elements of the C language with emphasis on the aspects used in the computational and data sciences. Conducted through a combination of lecture and interactive computer laboratory. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Recommended Prerequisite: CDS 130.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 290: *Topics in Computational and Data Sciences.* 1-4 credits.
Selected topics in Computational and Data Sciences. May be accepted for credit by CDS majors and CDS minors. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). May be repeated within the degree for a maximum 6 credits.
Specialized Designation: Topic Varies

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 292: *Introduction to Social Network Analysis.* 3 credits.
A broad introduction to network methods and applications that examine systems based on relations, structures, connectivity, location, interactions, and other network properties. This class includes, but is not limited to, social networks. Example applications covered will include: infrastructure networks, politics, diseases, and organizations, along with a variety of other phenomena. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Mason Core: Mason Core, Quantitative Reasoning (https://catalog.gmu.edu/mason-core/)

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

300 Level Courses

CDS 301: *Scientific Information and Data Visualization.* 3 credits.
The techniques and software used to visualize scientific simulations, complex information, and data visualization for knowledge discovery. Includes examples and exercises to help students develop their understanding of the role visualization plays in computational science and provides a foundation for applications in their careers. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Recommended Prerequisite: CDS 101 or CDS 130 or equivalent, or permission of instructor.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 302: *Scientific Data and Databases.* 3 credits.
Data and databases used by scientists. Includes basics about database organization, queries, and distributed data systems. Student exercises will include queries of existing systems, along with basic design of simple database systems. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Mason Core: Mason Core, Writing Intensive in Major (https://catalog.gmu.edu/mason-core/)

Recommended Prerequisite: CDS 101 or CDS 130 or equivalent, or permission of instructor.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 303: *Scientific Data Mining.* 3 credits.
Data mining techniques from statistics, machine learning, and visualization to scientific knowledge discovery. Students will be given a set of case studies and projects to test their understanding of this field and provide a foundation for future applications in their careers. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Recommended Prerequisite: CDS 101 or CDS 130 or equivalent, or permission of instructor.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 321: *Elements of Natural Language Processing.* 3 credits.
This course teaches the fundamentals of natural language processing (NLP) and natural language understanding (NLU) and helps develop necessary skills for beginner and intermediate level computational linguistics models, useful for analyzing text or speech from different human languages. This course teaches various NLP/NLU methods, including text mining, text analyses and parsing, topic modeling, semantic similarities, vector representations of words, and gives an introduction to large language models (LLMs). Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to two attempts.
Recommended Prerequisite: CDS 303

Registration Restrictions:
Required Prerequisites: CDS 101^C, 130^C and 230^C.
^{C} Requires minimum grade of C.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 351: *Elements of High Performance Computing.* 3 credits.
The course explores aspects of high-performance computing (HPC) based on a diverse set of tools, including Unix basics, file systems,

command scripts, Git, C++ programming, basics of parallel programming, and HPC system architectures. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to two attempts.

Registration Restrictions:
Required Prerequisite: CDS 251^C.
^{C} Requires minimum grade of C.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

400 Level Courses

CDS 403: *Machine Learning Applications in Science.* 3 credits.
Covers practical applications in STEM areas of decision trees, rule-based classification, support vector machines, Bayesian networks, ensemble methods, and Neural Networks. Emphasis resides on the process of applying machine learning effectively to a variety of problems. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.

Registration Restrictions:
Required Prerequisites: (CDS 230^C or 230^{XS}) and (MATH 203^C or 203^{XS}) and (CDS 303^C or 303^{XS}).
^{C} Requires minimum grade of C.
^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 410: *Numerical Analysis II.* 3 credits.
Numerical differentiation and integration, initial-value and boundary-value problems for ordinary differential equations, methods of solution of partial differential equations, iterative methods of solution of nonlinear systems, and approximation theory. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts. Equivalent to MATH 447.
Recommended Prerequisite: MATH 214 and MATH 446, proficiency in at least one computer programming language and computer operating system; or permission of instructor.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 411: *Modeling and Simulation II.* 3 credits.
Covers the application of modeling and simulation methods to various scientific applications, including fluid dynamics, solid mechanics, materials science, molecular mechanics, and astrophysics. Provides an introduction to modeling and simulation software, as well as high-performance computing. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Recommended Prerequisite: MATH 203, PHYS 262 or PHYS 245 or higher-level programming course, or permission of instructor.

Registration Restrictions:
Required Prerequisite: CDS 230^C.
^{C} Requires minimum grade of C.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 421: *Computational Data Science.* 3 credits.
Covers the governing framework of data science for storing and processing big data in a distributed computer environment using simple programming models. Includes a comprehensive selection of tools from Hadoop, MapReduce, HDFS, Spark, Flink, Hive, HBase, MongoDB, Cassandra, Kafka. Students are expected to complete several computer projects using these cyber packages. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Recommended Prerequisite: CDS 251 or equivalent computer programming language, and knowledge of computer operating system, or permission of instructor.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 461: *Molecular Dynamics and Monte Carlo Simulations.* 3 credits.
Covers particle methods to solve variety of physical systems. Emphasizes study of structure and thermodynamics of condensed systems in liquid and solid phases while implementing numerically the Molecular Dynamics and Monte Carlo methods. Applications and projects include a variety of atomistic and molecular simulations based on pairwise interatomic interactions. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to two attempts.
Recommended Prerequisite: Competency in programming at CDS 251 level or higher, PHYS 243 or equivalent, and MATH 214 or MATH 216, or permission of the instructor.

Registration Restrictions:
Required Prerequisite: CDS 251^C.
^{C} Requires minimum grade of C.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 465: *Modeling Interactive Populations.* 3 credits.
Employs several computational methods to create an agent-based model of an evolving and interactive population. Applied scenarios will include human identification through DNA profiles, community analysis through connected graphs, data generation, virus tracking, and evolution of human traits in time. Software skills developed will include Python, Pandas, and SQL. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CDS 230^C and 302^C).
^{C} Requires minimum grade of C.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 468: *Image Operators and Processing.* 3 credits.
An introductory examination of image mathematics, computational protocols, and applications. Topics include image operator notation, channel operators, informational operators, intensity operators, geometric operators, image transformations, frequency filtering, and image basis set expansions. This course will build the students' computational skill set as applied to visual data and create a library of image analysis scripts. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to two attempts.
Recommended Prerequisite: CDS 230 or equivalent.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 486: *Advanced Topics in Computational and Data Sciences.* 3 credits.
Covers selected topics in computational and data sciences not covered in fixed content courses. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). May be repeated within the degree for a maximum 6 credits.
Specialized Designation: Topic Varies

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 490: *Directed Study and Research.* 1-3 credits.
Students work under the guidance of a faculty member on an independent study or directed research project in the computational and data sciences. May be repeated in combination with CDS 491 for a total of 6 credits between the two classes. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). May be repeated within the degree for a maximum 6 credits.
Recommended Prerequisite: Students must be CDS majors or minors in their junior or senior year and have permission of the instructor.

Schedule Type: Independent Study

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 491: *Internship.* 1-3 credits.
On-the-job experience for CDS majors and minors working in industry and government laboratories, including summer programs. Supervision and approval of this course must be arranged with department before registering. May be repeated in combination with CDS 490 for a total of 6 credits between the two classes. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Students must be CDS majors or minors in their junior or senior year and have permission of the instructor.

Schedule Type: Internship

Grading:
This course is graded on the Satisfactory/No Credit scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 492: *Capstone in Data Science.* 3 credits.
This course is intended to provide a capstone experience for undergraduate students by synthesizing knowledge and experience that they acquired in earlier coursework to address a complex Data Science problem. This course requires analytical, collaborative, and communication skills. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). Limited to three attempts.
Mason Core: Mason Core, Mason Apex (https://catalog.gmu.edu/mason-core/)

Recommended Prerequisite: CDS 230 and (CDS 301 or CDS 302) or permission of instructor.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

500 Level Courses

CDS 501: *Scientific Information and Data Visualization.* 3 credits.
Techniques and software used to visualize scientific simulations, complex information, and data visualization for knowledge discovery. Includes examples and exercises to help students develop their understanding of the role visualization plays in computational science and provides a foundation for applications in their careers. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). May not be repeated for credit.
Recommended Prerequisite: CDS 130 or CDS 101; or permission of instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CDS 502: *Introduction to Scientific Data and Databases.* 3 credits.
Data and databases used by scientists. Includes basics about database organization, queries, and distributed data systems. Student exercises will include queries of existing systems, along with basic design of database systems. Examples from different disciplines will be given. Offered by Computational & Data Sciences (https://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/). May not be repeated for credit.

Recommended Prerequisite: CDS 130 or CDS 101; or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)