Computer Science (CS)

100 Level Courses

CS 100: Principles of Computing. 3 credits.
This course is intended to help students learn to think in the manner necessary to fully grasp the nature and power of the digital world around us. The early era of the Internet and the personal computer led to the need for "computer literacy." Now, the changing nature of our global society requires that students learn new ways to think about problems and how to solve them, regardless of students' specific fields of endeavor. Through this course, students will explore major issues related to the "big ideas" of computational thinking (namely, (i) Creativity, (ii) Abstraction, (iii) Data, (iv) Algorithms, (v) Programming, (vi) Internet, and (vii) Societal Impact), as well as how these issues will impact their future lives. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Mason Core: Info Tech & Computing (http://catalog.gmu.edu/mason-core/)

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

CS 101: Preview of Computer Science. 2 credits.
Offers a broad overview of computer science designed to provide students with an introduction to the field of computer science and an orientation to the Computer Science department and the computing environment at the university. Includes a project to introduce problem solving using computers. All computer science majors are required to take this course within their first year. Notes: All computer science majors are required to take this course within their first year. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisite: CS 112
C May be taken concurrently.
C Requires minimum grade of C.

Enrollment is limited to students with a major in Applied Computer Science or Computer Science.

Enrollment limited to students in a Bachelor of Science degree.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

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

CS 110: Essentials of Computer Science. 3 credits.
Offers a broad overview of computer science designed to provide computer science majors with an introduction to their discipline. Fundamental computing concepts such as number representation, programming environments, communication tools, and basic network security measures are covered. Privacy and ethical use of computing are also discussed along with guest lectures to sample current computer science research. Note: All computer science majors are required to take this course within their first year as a computer science major.

Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Enrollment limited to students in the VS-BS-ACS or VS-BS-CS programs.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

CS 112: Introduction to Computer Programming. 4 credits.
Rigorous introduction to problem solving through development of computer programs. Focuses on identifying algorithmic patterns in problems, describing problem solutions in high-level pseudocode, then implementing in a procedural programming language. Basic programming concepts are covered in detail including expressions, control structures, simple data types, and input/output. Program testing and debugging are discussed to verify that problems are solved correctly. Note: The department will drop students who fail to meet the prerequisites. Lectures and Labs are offered in groups. Students MUST register for a lecture and a lab from the same group. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Mason Core: Info Tech & Computing (http://catalog.gmu.edu/mason-core/)

Registration Restrictions:
Required Prerequisites: (minimum score of 65 in 'Math Placement Transcendentals', minimum score of 07 in 'Math Placement Transcendentals', MATH 105C, 105T, 104C, 104T, 113C or 123C.
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Laboratory, Lecture

200 Level Courses

CS 211: Object-Oriented Programming. 3 credits.
Thorough treatment of programming according to object-oriented principles. Introduces classes, interfaces, inheritance, polymorphism, and
single dispatch as means to decompose problems. Covers intermediate programming techniques including error handling through exceptions, arrangement of source code into packages, and simple data structures. Intermediate debugging techniques and unit testing are covered. Note: Lectures and labs are offered in groups. Students MUST register for a lecture and a lab from the same group. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisite:** (CS 105 or CS 110)
\(C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Laboratory, Lecture

**CS 222: Computer Programming for Engineers.** 3 credits.
Introduction to C as a second programming language with emphasis on problems and language features relevant to engineers. Topics include basic data types, pointers, elementary data structures, file/output, bitwise operations, and Unix commands for compilation and debugging. Intended as terminal course in computer programming. Notes: Intended as terminal course in computer programming. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisite:** (CS 112)
\(C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 262: Introduction to Low-Level Programming.** 3 credits.
Introduction to the language C, as well as operating system concepts, in UNIX, to prepare students for topics in systems programming. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** (CS 110 or 101) and (CS 211 or 222)
\(C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Laboratory, Lecture

**300 Level Courses**

**CS 306: Synthesis of Ethics and Law for the Computing Professional.** 3 credits.
Practical course to become effective computer professional. Examines legal and ethical issues surrounding computer technology and its use, as well as the foundation building that is necessary to deal with those challenges. Applies philosophical bases for ethical decision making to modern concerns raised by computers and technology. Addresses topics covered by CS 105 and CS 110 in a more intensive manner and focuses on the emerging legal and ethical issues involved in e-commerce and widespread use of the Internet. Notes: Computer science majors may use this course to satisfy the Mason Core synthesis requirement, so long as they have not previously taken CS 306 for credit. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Mason Core:** Synthesis (http://catalog.gmu.edu/mason-core/)

**Specialized Designation:** Writing Intensive in Major

**Recommended Prerequisite:** Junior standing (at least 60 credit hours).

**Recommended Corequisite:** All required Mason Core courses.

**Registration Restrictions:**
**Required Prerequisites:** (COMM 100 or 101) and (ENGH 302) or (HNRS 110 or 122) or (HNRS 110 and 130) or (HNRS 131, 240, 260, 261, 306 or 361)
\(C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 310: Data Structures.** 3 credits.
Focuses on object-oriented programming with an emphasis on tools and techniques for developing moderate to large programs. Topics include use and implementation of linear and nonlinear data structures and the design and analysis of elementary algorithms. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Recommended Corequisite:** CS 105 or CS 110

**Registration Restrictions:**
**Required Prerequisites:** (CS 211 or (MATH 113 or 124))
\(C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 321: Software Engineering.** 3 credits.
An introduction to concepts, methods, and tools for the creation of large-scale software systems. Methods, tools, notations, and validation techniques to analyze, specify, prototype, and maintain software requirements. Introduction to object-oriented requirements modeling, including use of case modeling, static modeling, and dynamic modeling using the Unified Modeling Language (UML) notation. Concepts and methods for the design of large-scale software systems. Fundamental design concepts and design notations are introduced. A study of object-oriented analysis and design modeling using the UML notation. Students participate in a group project on software requirements, specification, and object-oriented software design. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts. Equivalent to SWE 321.

**Specialized Designation:** Writing Intensive in Major

**Registration Restrictions:**
**Required Prerequisites:** CS 310 or (ENGH 110 or 131 or 130)
\(C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture
Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 325: Introduction to Game Design.** 3 credits.
Game design, in various electronic entertainment technologies, involves a diverse set of skills and backgrounds from narrative and art to computer programming. Surveys the technical aspects of the field, with an emphasis on programming. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
- **Required Prerequisite:** (CS 211^C). 
  - ^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 330: Formal Methods and Models.** 3 credits.
Abstract concepts that underlie much advanced work in computer science, with major emphasis on formal languages, models of computation, logic, and proof strategies. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
- **Required Prerequisites:** (CS 211^C and MATH 125^C). 
  - ^C Requires minimum grade of C.

Enrollment is limited to students with a major, minor, or concentration in Applied Computer Science, Computer Science or Software Engineering.

Enrollment limited to students in a Bachelor of Science or Post-Baccalaureate Certificate degrees.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 332: Object-Oriented Software Design and Implementation.** 3 credits.
In-depth study of software design and implementation using a modern, object-oriented language with support for graphical user interfaces and complex data structures. Topics covered will be specifications, design patterns; and abstraction techniques; including typing, access control, inheritance, and polymorphism. Students will learn the proper engineering use of techniques such as information hiding, classes, objects, inheritance, exception handling, event-based systems, and concurrency. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts. Equivalent to SWE 332.

**Registration Restrictions:**
- **Required Prerequisite:** (CS 310^C). 
  - ^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

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

**CS 351: Visual Computing.** 3 credits.
Focuses on programming essential mathematical and geometric concepts underlying computer graphics. Covers fundamental topics in computational geometry, 3D modeling, graphics algorithms, and graphical user interfaces using both 2D and 3D implementations. Reinforces object-oriented programming practices. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
- **Required Prerequisites:** (CS 262^C and 310^C). 
  - ^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 367: Computer Systems and Programming.** 4 credits.
Introduces students to computer systems from a programmer's perspective. Topics include data representation, assembly and machine-level representation of high-level language programs, the memory hierarchy, linking, exceptions, interrupts, processes and signals, virtual memory, and system-level I/O. Foundation for courses on compilers; networks; operating systems; and computer architecture, where a deeper understanding of systems-level issues is required. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
- **Required Prerequisites:** (CS 262^C or 222^C) and MATH 125^C and CS 110^C. 
  - ^C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture, Recitation

**CS 390: Research and Project Design Principles in Computing.** 3 credits.
This course introduces students to the research and project design process within the computing field. Students will learn about the tools of the trade, work through design principles beginning with the articulation of a question, reviewing methods of exploration, gathering evidence, communicating results, and assessing and evaluating research or project outcomes. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Specialized Designation:** Mason Impact.

**Recommended Prerequisite:** Mason Impact.

**Registration Restrictions:**
- **Required Prerequisite:** CS 310 and CS 321.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 391: Advanced Programming Lab.** 1 credit.
Programming-intensive lab course. Students refine problem-solving and programming skills while gaining experience in teamwork. Focuses on data structures, recursion, backtracking, dynamic programming, and
debugging. Central focus is applying familiar and new algorithms and data structures to novel circumstances. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree for a maximum 3 credits.

Registration Restrictions:
Required Prerequisite: CS 310C.
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Laboratory

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

**CS 395: Student Initiated Special Topics.** 1 credit.
Special and emerging topics of interest to computer science undergraduates. Lectures are taught by student/faculty teams. Notes: May be repeated if topics are substantially different. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the term for a maximum 3 credits.

Specialized Designation: Topic Varies

Recommended Prerequisite: Additional pre-requisites will vary by topic

Registration Restrictions:
Required Prerequisite: CS 211C.
C Requires minimum grade of C.

Enrollment is limited to students with a major in Applied Computer Science or Computer Science.

Enrollment limited to students in a Bachelor of Science degree.

Schedule Type: Lecture

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

**CS 399: Special Topics.** 3 credits.
Special and emerging topics in computer science or closely related disciplines. Notes: May be repeated if topics are substantially different. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the term for a maximum 6 credits.

Specialized Designation: Topic Varies

Recommended Prerequisite: Additional prerequisites will vary by topic.

Registration Restrictions:
Required Prerequisite: CS 211C.
C Requires minimum grade of C.

Schedule Type: Lecture

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

**400 Level Courses**

**CS 425: Game Programming I.** 3 credits.
Introduction to technologies and techniques used in modern computer games. Teams will explore the various facets of a complete design using sophisticated tools. Includes a project in which a game is prototyped; this prototype and initial design will serve as the starting point for the project in CS 426. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 310C and 351C).
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

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

**CS 426: Game Programming II.** 3 credits.
Project-orientated continuation of CS 425 with an emphasis on the implementation of a complete game. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: CS 325C and 425C.
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

CS 440: Language Processors and Programming Environments. 3 credits.
Survey of basic programming language processors and software development tools such as assemblers, interpreters, and compilers. Topics include design and construction of language processors, formal syntactic definition methods, parsing techniques, and code-generation techniques. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 310C and (CS 330C) and (CS 367C)).
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

Schedule Type: Lecture

CS 444: Introduction to Computational Biology. 3 credits.
Introduces computational methods in molecular biology. Covers a broad array of topics in bioinformatics and computational biology. Organized as 3 four-week modules intended to capture the current classification of bioinformatics and computational biology methods, thereby providing students with a broad view of the field. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Recommended Prerequisite: C or better in CS 310.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

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

**CS 445:** *Computational Methods for Genomics.* 3 credits.
Fundamental principles and techniques for implementing computational algorithms to solve problems in biology arising from the need to process large volumes of genomic information. Topics include sequence analysis, alignment, and assembly, gene prediction, and knowledge-based protein structure prediction. Projects involve designing and programming basic alignment and prediction methods. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Recommended Prerequisite:** C or better in CS 310 and STAT 344.

**Registration Restrictions:**
Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

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

**CS 450:** *Database Concepts.* 3 credits.
Covers basics to intermediate knowledge for the design, implementation, and use of relational database systems. Topics include the Entity-Relationship (ER) and Entity-Enhanced Relationship (EER) models for database design, Relational Algebra (RA), Structured Query Language (SQL), SQL programming techniques, functional dependencies and normalization, object and object-relational databases, and security. Students will practice to design, develop, and implement a relational ORACLE database and use the database for queries, transaction processing, and report generation. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** (CS 310$^C$) and (CS 330$^C$).
$^C$ Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 451:** *Computer Graphics.* 3 credits.
Basic graphics principles and programming. Topics include scan conversion, transformation, viewing, lighting, blending, texture mapping, and some advanced graphics techniques. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** (MATH 203$^C$) and (CS 310$^C$) and (CS 367$^C$).
$^C$ Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

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

**CS 455:** *Computer Communications and Networking.* 3 credits.
Data communications and networking protocols, with study organized to follow layers of Internet Protocol Suite (TCP/IP family of protocols). Topics include role of various media and software components, local and wide area network protocols, network performance, and emerging advanced commercial technologies. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** (CS 310$^C$) and (CS 367$^C$) and (STAT 344$^C$).
$^C$ Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 463:** *Comparative Programming Languages.* 3 credits.
Key programming mechanisms described independently of particular machines or languages, including control, binding, procedural abstraction, types, and concurrency. Includes basic programming competence in several different types of programming languages, including a language that provides concurrency. Notes: Students who have taken CS 363 may not receive credit for CS 463. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** CS 330$^C$, 367$^C$ and 310$^C$.
$^C$ Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 465:** *Computer Systems Architecture.* 3 credits.

**Registration Restrictions:**
**Required Prerequisite:** (CS 367$^C$).
$^C$ Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 468:** *Secure Programming and Systems.* 3 credits.
Fundamental principles and techniques for implementing secure computer systems. Topics include security and cryptography basics, vulnerability analysis, secure software development, and distributed system security. Projects involve designing and programming basic security tools, secure programs, and distributed systems. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** (CS 310$^C$) and (CS 367$^C$).
$^C$ Requires minimum grade of C.
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

CS 469: Security Engineering. 3 credits.
Covers the software subsystems that are involved in defending computer systems. Studies threats and architecting solutions against them, including but not limited to access control and identity management, network and system security, intrusion detection and recovery systems, monitoring and forensic systems. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 330C) and (CS 367C) and (STAT 344C).
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (http://catalog.gmu.edu/policies/academic/grading/) CS 480: Introduction to Artificial Intelligence. 3 credits.
Principles and methods for knowledge representation, reasoning, learning, problem solving, planning, heuristic search, and natural language processing and their application to building intelligent systems in a variety of domains. Uses LISP, PROLOG, or expert system programming language. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 310C) and (CS 330C).
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

CS 482: Computer Vision. 3 credits.
Basic principles of visual perception and their implementation on computer systems. Topics include early visual processing, edge detection, segmentation, intrinsic images, image modeling, representation of visual knowledge, and image understanding. Students complete projects involving real images. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 310C) and (MATH 203C) and (STAT 344C).
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

CS 483: Analysis of Algorithms. 3 credits.
Analyzes computational resources for important problem types by alternative algorithms and their associated data structures, using mathematically rigorous techniques. Specific algorithms analyzed and improved. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 310C) and (CS 330C) and (MATH 125C).
**CS 491:** Industry-Sponsored Senior Design Project. 3 credits.

Senior design project course focusing on design and successful implementation of major software project specified by an industry sponsor, encompassing broad spectrum of knowledge and skills, developed by team of students. Requires final exhibition to faculty-industry panel. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree for a maximum 6 credits.

**Registration Restrictions:**
Required Prerequisites: CS 310\(^C\) and (STAT 344\(^C\) or 334\(^C\)).

\(^C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 480:** Design Exhibition. 3 credits.

Capstone course focusing on design and successful implementation of major software project, encompassing broad spectrum of knowledge and skills, developed by team of students. Requires final exhibition to faculty-industry panel. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree for a maximum 12 credits.

**Recommended Prerequisite:** Two other CS 400-level courses; and senior standing.

**Registration Restrictions:**
Required Prerequisites: (CS 321\(^C\) or 421\(^C\)) and (CS 483\(^C\)).

\(^C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 494:** Individual Study. 3 credits.

Enrollment is limited to students with a major, minor, or concentration in Applied Computer Science or Computer Science.

**Registration Restrictions:**
Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Independent Study

**CS 484:** Data Mining. 3 credits.

Basic principles and methods for data analysis and knowledge discovery. Emphasizes developing basic skills for modeling and prediction and performance evaluation. Topics include system design; data quality, preprocessing, and association; event classification; clustering; biometrics; business intelligence; and mining complex types of data. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
Required Prerequisites: CS 310\(^C\) and (STAT 344\(^C\) or 334\(^C\)).

\(^C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**CS 485:** Autonomous Robotics. 3 credits.

Covers various basic topics in autonomous robotics, such as autonomous architectures and their interaction with physical hardware, elementary kinematics and robot control, motion and trajectory planning, localization, task planning, learning and adaptation, modeling, and sensor fusion. Includes projects involving physical robots. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). Limited to two attempts.

**Registration Restrictions:**
Required Prerequisites: CS 262\(^C\), 310\(^C\) and MATH 203\(^C\).

\(^C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

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

**CS 490:** Special Topics in Computer Science. 3 credits.

Topics of special interest to undergraduates. Notes: May be repeated if topics substantially different. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the term for a maximum 6 credits.

**Recommended Prerequisite:** 60 credits, CS major, and Permission of Instructor.

**Registration Restrictions:**
Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Independent Study

**CS 498:** Independent Study in Computer Science. 1-3 credits.

Research and analysis of selected problems or topics in computer science. Topic must be arranged with instructor and approved by department chair before registering. Notes: May be repeated if topics substantially different. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the term for a maximum 6 credits.

**Registration Restrictions:**
Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Independent Study

**CS 499:** Special Topics in Computer Science. 3 credits.

Topics of special interest to undergraduates. Notes: May be repeated if topics substantially different. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the term for a maximum 6 credits.

**Recommended Prerequisite:** 60 credits. Additional prerequisites may vary with nature of topic.

**Registration Restrictions:**
Required Prerequisites: CS 310\(^C\) and 330\(^C\).

\(^C\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**500 Level Courses**

**CS 504:** Principles of Data Management and Mining. 3 credits.

Techniques to store, manage, and use data including databases, relational model, schemas, queries and transactions. On Line Transaction Processing, Data Warehousing, star schema, On Line Analytical Processing, MOLAP, HOLAP, and hybrid systems. Overview of Data Mining principles, models, supervised and unsupervised learning, pattern finding. Massively parallel architectures and Hadoop. Notes: This course cannot be taken for credit by students of the MS CS, MS ISA, MS SWE, CS PhD or IT PhD programs. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.
**Registration Restrictions:**
Enrollment is limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 530: Mathematical Foundations of Computer Science.** 3 credits.
This course focuses on the topics of basic mathematical structures, mathematical logic and probability theory, and application of these concepts to problem solving and formal reasoning through hand-on practice with the use of computational tools. Notes: May not be taken for credit by students in the PhD CS or accelerated MSCS programs. May only be taken in the first semester at GMU. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** MATH 125 and STAT 344.

**Registration Restrictions:**
Enrollment is limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 531: Computer Systems and Fundamentals of Systems Programming.** 3 credits.
This course is a hands-on introduction to the systems level of programming with an emphasis on data structures and interfacing with operating systems. This course focuses on fundamental data structures needed to design and implement systems applications and continues with an introduction to the Unix Application Programming Interface, signals, threads, and interprocess communications. This course is taught from a programmatic perspective using C, with special topics in both Java and Python. May not be taken for credit by students in the PhD CS or accelerated MSCS programs. May only be taken in the first semester at GMU. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 310 and CS 367 or equivalent.

**Registration Restrictions:**
Enrollment is limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 540: Language Processors.** 3 credits.
Basic programming language processors such as assemblers, interpreters, and compilers. Topics include design and construction of language processors, formal syntactic definition methods, parsing techniques, and code generation techniques. Lab includes construction of language processors and experience with programming environments. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 465.

**Registration Restrictions:**
Enrollment is limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 550: Database Systems.** 3 credits.
An introduction to database management with focus on architecting databases and using them in applications. Topics to be covered include: data modeling with the Entity-Relationship model, the relational data model and its formal languages, SQL, the theory of database design, object databases, XML and Web data. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** (CS 310 and CS 330) or (INFS 501 and INFS 515 and INFS 519 and SWE 510).

**Registration Restrictions:**
Enrollment is limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 551: Computer Graphics.** 3 credits.
Graphics principles and programming. Topics include graphics hardware, antialiasing, transformations, viewing, illumination, blending, texture mapping, color models, curves, surfaces, and animation. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 310 and CS 367.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 555: Computer Communications and Networking.** 3 credits. Techniques and systems for communication of data between computational devices and layers of Internet Protocol Suite. Topics include role of various media and software components, local and wide area network protocols, network design, performance and cost considerations, and emerging advanced commercial technologies. Emphasizes TCP/IP family of protocols. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 310 and CS 367 and STAT 344.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 571: Operating Systems.** 3 credits. Models of operating systems. Major functions including processes, memory management, I/O, interprocess communication, files, directories, shells, distributed systems, performance, and user interface. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 310 and CS 367 and CS 465.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 580: Introduction to Artificial Intelligence.** 3 credits. Principles and methods for knowledge representation, reasoning, learning, problem solving, planning, heuristic search, and natural language processing and their application to building intelligent systems in a variety of domains. LISP, PROLOG, or expert system programming language. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 310 and CS 330.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 583: Analysis of Algorithms.** 3 credits. Topics include analyzing sequential and parallel algorithmic strategies such as greedy methods, divide and conquer strategies, dynamic programming, search and traversal techniques, and approximation algorithms; and analyzing specific algorithms falling into these classes, NP-Hard and NP-Complete problems. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 310 and CS 330 and MATH 125.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 584: Theory and Applications of Data Mining.** 3 credits. Concepts and techniques in data mining and multidisciplinary applications. Topics include databases; data cleaning and transformation; concept description; association and correlation rules; data classification and predictive modeling; performance analysis and scalability; data mining in advanced database systems, including text, audio, and images; and emerging themes and future challenges. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 310 and STAT 344.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 587:** *Introduction to Cryptography.* 3 credits.
Covers formal definitions of security for the most common tasks: data encryption and authentication, in both the private key and public key settings. Covers the process of formally proving that constructions meet the appropriate security definitions. Also covers practical constructions and applications, such as how to correctly use block ciphers and hash functions for the tasks above. In addition, several current topics in cryptography may also be covered. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 330

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

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

**Specialized Designation:** Topic Varies

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

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

**Schedule Type:** Lecture

**CS 595:** *Basic Topics in Computer Science.* 3 credits.
Special topics in computer science not occurring in existing courses. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree for a maximum 9 credits.

**Specialization Designation:** Topic Varies

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

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

**Schedule Type:** Lecture

**CS 583:** *Theory of Computation.* 3 credits.
Introduction to logic and proof techniques, formal languages, automata theory, and computational complexity. Specific topics include regular and context-free languages, Turing machines, NP-completeness, and undecidability. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 583B.

B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 593:** Offers an overview of advanced algorithm design and analysis techniques. Topics include algorithms for hash tables, matrix operations, number theory, string matching, computational geometry, combinatorial optimization, and linear programming; also the areas of NP-completeness and approximation algorithms. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Required Prerequisite:** CS 583B.

B- Requires minimum grade of B-.

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

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

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

**CS 630:** *Advanced Algorithms.* 3 credits.
Provides an overview of advanced algorithm design and analysis techniques. Topics include algorithms for hash tables, matrix operations, number theory, string matching, computational geometry, combinatorial optimization, and linear programming; also the areas of NP-completeness and approximation algorithms. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Required Prerequisite:** CS 583B.

B- Requires minimum grade of B-.

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

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

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

**CS 600:** *Theory of Computation.* 3 credits.
Introduction to logic and proof techniques, formal languages, automata theory, and computational complexity. Specific topics include regular and context-free languages, Turing machines, NP-completeness, and undecidability. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Required Prerequisite:** CS 583B.

B- Requires minimum grade of B-.
Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the Volgenau School of Engineering.

Schedule Type: Lecture

CS 633: Computational Geometry. 3 credits.
Basic principles and methods for computing in field of geometric modeling. Emphasizes data structures used to represent geometric objects and algorithms for manipulating those data structures. Topics include range searching, polygon triangulation, convex hulls, motion-planning, visibility, and mesh generation. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 583B.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering.

Schedule Type: Lecture

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

CS 640: Advanced Compilers. 3 credits.
Examines advanced compiler techniques such as code optimizations for sequential and parallel machines; compilers for logical, functional, or object-oriented languages; and other topics in current literature. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisites: (CS 540B and 583B).
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering.

Schedule Type: Lecture

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

CS 650: Advanced Database Management. 3 credits.
Study of the internal architecture of database systems. Topics include: physical data organization and indexing, query processing and optimization, transaction processing, database system architectures, Web services and Web data security. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisites: (CS 550B or INFS 614B).
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering.

Schedule Type: Lecture

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

CS 655: Wireless and Mobile Computing. 3 credits.
This course provides an introduction to wireless and mobile networking. Topics include principles and architectures of wireless and mobile networking and fundamental issues of wireless communications with energy-constrained, mobile devices. It discusses physical, data link and network layer protocols including IEEE 802.11, and emerging wireless
networks such as Internet-of-Things, high-speed millimeter-waves, vehicular networks, and mobile and IoT sensing applications including indoor localization, smart-homes, and smart-cities. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 555

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

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

**Schedule Type:** Lecture

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

**CS 657: Mining Massive Datasets with MapReduce.** 3 credits.
Covers the techniques to mine large datasets, including Distributed File Systems and Map-Reduce, similarity search, and data stream processing. Covers classic problems in data mining, such as clustering, association rule mining, and others from the point of view of scalability. Includes a final project to exercise concepts covered in class. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** CS 584\(^B\)\.
\(^B\) Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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. (http://catalog.gmu.edu/policies/academic/grading/)

**CS 662: Computer Graphics Game Technologies.** 3 credits.
Addresses some graphics game techniques including collision detection, levels of detail, physics-based simulations, textures, maps, and shadows. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** CS 555\(^B\).
\(^B\) Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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. (http://catalog.gmu.edu/policies/academic/grading/)

**CS 667: Biometrics and Identity Management.** 3 credits.
Basic principles and methods for automatic authentication of individuals. Technologies include face, fingerprint, and iris recognition; and speaker verification. Additional topics cover multimodal biometrics, system design, performance evaluation, and privacy concerns. Term project required. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** CS 580\(^B\).
\(^B\) Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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. (http://catalog.gmu.edu/policies/academic/grading/)

**CS 551: Basic Principles and Methods for Automatic Authentication of Individuals.** 3 credits.
Basic principles and methods for automatic authentication of individuals. Technologies include face, fingerprint, and iris recognition; and speaker verification. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.
Schedule Type: Lecture

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

CS 672: Computer System Performance Evaluation. 3 credits.
Theory and practice of analytical models of computer systems. Topics include open and closed multiclass queuing networks, single and multiple class Mean Value Analysis, Markov Chains, performance and availability models of Internet data centers, software performance engineering, and e-commerce performance. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 571B-.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 673: Multimedia Computing and Systems. 3 credits.
Focuses on technological and development environments in developing multimedia applications. Projects involve experience with multimedia authoring tools and simulations to assess performance. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 571B-.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 675: Distributed Systems. 3 credits.
Issues in design and implementation of distributed systems and applications. Topics include distributed communication paradigms, middleware, coordination and synchronization, distributed transactions, consistency and replication, fault-tolerance and reliability, and peer-to-peer systems. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 571B-.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 681: Instructable Cognitive Agents. 3 credits.
Design and development of cognitive agents that learn problem-solving expertise directly from domain experts. Topics include modeling expert’s knowledge, mixed-initiative reasoning based on knowledge and evidence, ontology design and development, multistrategy rule learning, and knowledge-based maintenance. Projects include development of specific cognitive agents through teaching and learning. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 580B-.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 682: Computer Vision. 3 credits.
Study of computational models of visual perception and their implementation in computer systems. Topics include early visual processing, edge detection, segmentation, intrinsic images, image modeling, representation of visual knowledge, and image understanding. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisites: (CS 580B- and (CS 583B- or 584B-)).
B- Requires minimum grade of B-.
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

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

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

Enrollment limited to students in the Volgenau School of Engineering.

Schedule Type: Lecture

CS 683: Parallel Algorithms. 3 credits.
Examines design and analysis of parallel algorithms. Material focuses on algorithms for both theoretical and practical models of parallel computation. Considers algorithm design and analysis for PRAM and existing SIMD and MIMD type architectures. Topics include sorting, graph algorithms, numerical algorithms, and computational complexity. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 583B.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 685: Autonomous Robotics. 3 credits.
Reviews developments in intelligent autonomous systems. Studies applications of artificial intelligence, computer vision, and machine learning to robotics. Topics include analysis and design of algorithms and architectures for planning, navigation, sensory data understanding, sensor fusion, spatial reasoning, motion control, knowledge acquisition, learning concepts and procedures, self-organization, and adaptation to environment. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 580B.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 686: Image Processing and Applications. 3 credits.
Concepts and techniques in image processing. Discusses methods for image capture, transformation, enhancement, restoration, and encoding. Students complete projects involving naturally occurring images. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 583B.
B- Requires minimum grade of B-.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (http://catalog.gmu.edu/policies/academic/grading/)
**CS 687: Advanced Artificial Intelligence.** 3 credits.
Explores foundational issues of artificial intelligence, such as roles of knowledge and search, formalization of knowledge and inference, and symbolic versus emergent approaches to intelligence. Studies advanced programming techniques for artificial intelligence, relationship to foundational issues, and important application areas for artificial intelligence. Notes: Major programming project required. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** CS 580^B^.
^B^ Requires minimum grade of B-

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

**CS 688: Machine Learning.** 3 credits.
This course covers the theory and principles underlying different machine learning paradigms. The emphasis is on statistical theory and methodology. Topics include: Model selection and generalization; Overfitting and under fitting; Bayesian theory and Decision theory; Maximum Likelihood estimation, MAP; Regularization; Bias-variance tradeoff; Curse of dimensionality; Dimensionality reduction; Linear Models for classification; Probabilistic Generative Models; Probabilistic Discriminative Models; Neural Networks (Backpropagation); Deep Learning (CNNs); Kernel methods; Support Vector Machines; Ensemble Methods; Unsupervised Learning (Clustering, EM, Mixture Modeling); Reinforcement learning. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisites:** CS 580^B^ or 584^B^.
^B^ Requires minimum grade of B-

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 695:** Independent Reading and Research. 1-3 credits.
Students may undertake a course of study under supervision of consenting faculty member. Students usually submit written statement of course content and tentative reading list as part of request for approval.
Literature review, project report, or other written product usually required. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** Completion of at least two core courses, and permission of the instructor.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, 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.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Research

### 700 Level Courses

**CS 700: Research Methodology in Computer Science.** 3 credits. Topics include approaches for evaluating, writing, and presenting scholarly papers, research integrity issues, and quantitative models and methods in experimental computer science. Techniques for the use of analytic and simulation models, design of experiments, hypothesis testing, and statistical analysis of data are presented. Students apply these techniques to a project, write a report, and make a presentation to the class. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** Admission to PhD in Computer Science or PhD in Information Technology programs.

**Registration Restrictions:**
Enrollment limited to students with a major in Computer Science or Information Technology.

Enrollment limited to students in a Doctor of Philosophy degree.

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 701: Research Experience in Computer Science.** 3 credits. Readings and research for early stage PhD students under the direction of a Computer Science faculty member. Research findings must be reported in a professionally prepared document and presented in a public meeting at the end of the semester. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the term for a maximum 3 credits.

**Recommended Prerequisite:** CS 700

**Registration Restrictions:**
Enrollment limited to students in a Doctor of Philosophy degree.

**Schedule Type:** Research

**CS 706: Concurrent Software Systems.** 3 credits. Topics include concurrent programming languages and constructs, and specification, design, verification, and validation of concurrent programs. Students required to solve concurrent programming problems and check solutions by using verification, testing, and debugging tools. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** CS 571B-
B- Requires minimum grade of B-.

Enrollment limited to Graduate or Non-Degree level students.

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

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 719: Scalable Internet Services.** 3 credits. Discusses, from quantitative point of view, characteristics of most important technologies used to support implementation of e-business sites. Includes topics such as hardware and software architectures of e-business sites, authentication, payment services, understanding customer behavior, workload characterization, scalability analysis, and performance prediction. Notes: Term paper and project required. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisites:** (CS 555B- and 571B-).
B- Requires minimum grade of B-.

Enrollment limited to Graduate or Non-Degree level students.

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

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 747: Deep Learning.** 3 credits. This course presents the theory, underlying principles and applications of Deep Learning (DL). Deep learning is a Machine Learning approach based on learning data representations as opposed to designing task-specific algorithms. The course covers the concepts of Multilayer Perceptrons (MLPs) and algorithms to train them (gradient descent, backpropagation), Regularization of DL, Convolutional Networks (CNNs), Autoencoders, Recurrent Networks (RNNs), and Deep Generative Models including Generative Adversarial Methods. Problems from various application domains such as natural language processing and computer vision will
be discussed. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** CS 688

**Registration Restrictions:**
Enrollment is limited to students with a major in Computer Science or Software Engineering.

Enrollment limited to students in a Master of Science degree.

**Schedule Type:** Lecture

**CS 752: Interactive Graphics Software.** 3 credits.
Advanced graphics methods and tools. Topics include visualization, modeling, rendering, animation, simulation, virtual reality, graphics software tools, and current research topics. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisites:** (CS 551B and 583B).
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 755: Advanced Computer Networks.** 3 credits.
Current and emerging issues in advanced computer networks and applications. Topics include software systems associated with packet and cell-switched networking architectures and protocols, high-performance LANs, scheduling and congestion control, mobile networking, multimedia applications, and next generation of Internet. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** CS 555B.
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 773: Real-Time Systems Design and Development.** 3 credits.
Real-time systems and principles supporting design and implementation. Emphasizes fundamental results from real-time scheduling theory and relevance to computer system design. Topics include system design issues for real-time applications involving operating systems, communication networks, databases, and multimedia. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** CS 571B.
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 774: Computational Vision.** 3 credits.
Studies recent advances in development of machine vision algorithms and knowledge-based vision systems. Topics include scale-space; Gabor and wavelet processing; distributed and hierarchical processing using neural networks; motion analysis; active, functional, and selective perception; object and target recognition; expert systems; data fusion; and machine learning. Emphasizes system integration in terms of perception, control, action, and adaptation. Presents applications to robotics, intelligent highways, inspection, forensic, and data compression. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**
**Required Prerequisite:** (CS 682B and 686B).
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 775: Advanced Pattern Recognition. 3 credits.
Covers statistical pattern recognition, neural network, and statistical learning theory approaches. Topics include decision theory and Bayes’ theorem, density (parametric and nonparametric) estimation, linear and nonlinear discriminant analysis, SVM and kernel methods, SRM and model selection, performance evaluation, mixture of experts (AdaBoost), dimensionality reduction, feature selection and extraction, and clustering. Emphasizes experimental design, applications, and performance evaluation. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisite: CS 688<sup>B-</sup>.
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 777: Human-Computer Intelligent Interaction. 3 credits.
Current and emerging issues in human-computer intelligent interaction, and human-centered systems and their applications. Topics include video processing, visualization, virtual environments, adaptation and tutoring, image and scene modeling, analysis and synthesis, face and gesture recognition, and speech and natural language processing. Notes: Term project and topical review required. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisites: (CS 580<sup>B-</sup> and 551<sup>B-</sup>) or (CS 682<sup>B-</sup>).
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 779: Topics in Resilient and Secure Computer Systems. 3 credits.
Covers study of alternate computer security, including how these methods can be combined in a layered defense and factors that affect the selection of the architectures. Reviews recent papers and reports. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Specialized Designation: Topic Varies

Registration Restrictions:
Required Prerequisites: CS 571<sup>B-</sup> or ISA 562<sup>B-</sup>.
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 782: Advanced Machine Learning. 3 credits.
The course covers recent advances in the field of machine learning. Possible topics include: Learning Theory (PAC, error bounds, VC-dimension); Learning manifolds; Transfer learning; Active learning; Learning with structured data (e.g. graphs); Topic modeling; Learning with text; Graphical Models (Bayesian Networks); Learning HMMs. Topics may change depending on the instructor. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

Registration Restrictions:
Required Prerequisites: (CS 681<sup>B-</sup>, 687<sup>B-</sup> or 688<sup>B-</sup>).
B- Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 787: Decision Guidance Systems. 3 credits.
Decision-guidance systems support an iterative process of giving actionable recommendations to and extracting feedbacks from human decision-makers, with the goal of arriving at the best possible course of action. Focuses on models, languages, algorithms and applications of Decision-Guidance Management Systems, used for fast development of decision-guidance applications. Offered by Computer Science (http://
catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**

**Required Prerequisites:** (INFS 614\(^B\) or CS 550\(^B\)).

\(^B\) Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 788: *Autonomic Computing*. 3 credits.

Studies self-managing, self-optimizing, self-configuring, self-tuning, self-healing, and self-protecting computing systems. This course analyzes many examples of autonomic systems as well as various techniques to design and build such systems. This is a doctoral seminar based on reading and analysis of current papers. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Registration Restrictions:**

**Required Prerequisites:** (CS 555\(^B\), 571\(^B\) or ISA 562\(^B\)).

\(^B\) Requires minimum grade of B-.

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Lecture

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

CS 798: *Project Seminar*. 3 credits.

Master's degree candidates undertake a project using knowledge gained in MS program. Notes: Topics chosen in consultation with advisor. Meets project or thesis requirement for MS in computer science. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit.

**Recommended Prerequisite:** 18 hours of credit applicable toward the M.S. in computer science.

**Registration Restrictions:**

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Thesis

Grad: This course is graded on the Graduate Special scale. (http://catalog.gmu.edu/policies/academic/grading/)


Original or expository work evaluated by committee of three faculty members. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree.

**Recommended Prerequisite:** 18 hours of credit applicable toward the M.S. in Computer Science.

**Registration Restrictions:**

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

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

Enrollment limited to students in the Volgenau School of Engineering college.

Schedule Type: Thesis

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

800 Level Courses

CS 800: *Computer Science Colloquium*. 0 credits.

Students are required to attend colloquia including talks by distinguished speakers, faculty candidates, and Mason faculty. Notes: This course introduces PhD students to research topics in computer science. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree for a maximum 2 credits.

**Registration Restrictions:**

Enrollment is limited to students with a major in Computer Science.

Enrollment limited to students in a Doctor of Philosophy degree.
Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Seminar

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

**CS 895:** Research Topics in CS. 3 credits.
Advanced topics not occurring in regular sequence. Notes: May be repeated for credit when subject differs. Only one such course should be used for breadth requirements. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the term.

**Specialized Designation:** Topic Varies

**Recommended Prerequisite:** Doctoral status.

**Registration Restrictions:**
Enrollment limited to Graduate level students.
Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Lecture

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

**CS 896:** Directed Reading and Research. 1-6 credits.
Reading and research on a specific topic under the direction of a faculty member. Notes: Students can sign up for this class only after satisfying the CS PhD breadth requirement. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree for a maximum 18 credits.

**Recommended Prerequisite:** Permission of Instructor.

**Registration Restrictions:**
Enrollment limited to students in the VS-PHD-CS program.
Enrollment is limited to Graduate level students.
Enrollment limited to students in a Doctor of Philosophy degree.
Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Research

**900 Level Courses**

**CS 990:** Dissertation Topic Presentation. 0 credits.
Students put together a professional presentation of a research proposal and present it for critique to fellow students and interested faculty. Notes: Must be completed before the presentation of a dissertation research proposal. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May not be repeated for credit. Equivalent to CEIE 990, IT 990, STAT 990.

**Recommended Prerequisite:** Student must have passed the PhD qualifying examinations.

**Registration Restrictions:**
Enrollment is limited to Graduate level students.
Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Research

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

**CS 998:** Doctoral Dissertation Proposal. 1-12 credits.
Work on a research proposal that forms the basis for a doctoral dissertation. Notes: No more than 24 credits of CS 998 and 999 may be applied to the doctoral degree requirements. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree.

**Recommended Prerequisite:** Student must have passed the PhD qualifying examinations and must have a dissertation advisor.

**Registration Restrictions:**
Enrollment limited to Graduate level students.
Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Dissertation

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

**CS 999:** Doctoral Dissertation. 1-12 credits.
Dissertation research under the supervision of the dissertation director. Notes: No more than 24 credits of CS 998 and 999 may be applied to the doctoral degree requirements. Offered by Computer Science (http://catalog.gmu.edu/colleges-schools/engineering/computer-science/). May be repeated within the degree.

**Recommended Prerequisite:** Admission to candidacy.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy.
Enrollment is limited to Graduate level students.
Enrollment limited to students in the Volgenau School of Engineering college.

**Schedule Type:** Dissertation

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