

Data Science, Certificate

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Master of Science Program Director: Praveen Madiraju, Ph.D.

Certificate Program Director: Walter Bialkowski, Ph.D.

Department of Computer Science website (<https://www.marquette.edu/computer-science/>)

Data Science Certificate website (<https://www.marquette.edu/grad/programs-data-science-certificate.php>)

Department Affiliation

The data science certificate is affiliated with the Department of Computer Science in the Klingler College of Arts and Sciences.

Degree Offered

Certificate

Program Description

The data science certificate curriculum is designed to connect data analytics and data science skills and knowledge with the needs evident in a host of fields. This program seeks to meet a significant need for data analytics experts, targeting a human-centered approach.

Learning outcomes for students completing the certificate program:

1. Identify and articulate problems, issues and decisions that can be informed by data analytics approaches and the ethical and social issues surrounding them.
2. Design and implement advanced strategies for analyzing big data.
3. Create and present actionable information.

Data Science Certificate

All students admitted to the data science certificate program are required to complete at least 12 credit hours of course work.

This ethically-centered graduate certificate is in the emerging interdisciplinary field of data science, which seeks to extract and quantify knowledge from large and/or heterogeneous data sets. The certificate prepares students to integrate advanced technology with modern statistical and mathematical practices and use data in action to directly benefit society. Students learn how to turn data into knowledge, thereby guiding problem-solving and decision-making.

Students must complete 12 credits of course work from the following courses:

Code	Title	Hours
COSC 6510	Data Intelligence	3
COSC 6520	Data Analytics	3
COSC 6570	Data at Scale	3
COSC 6820	Data Ethics	3

Total Credit Hours: 12

University Policies

- Academic Censure - Graduate School (<https://bulletin.marquette.edu/policies/academic-censure/graduate/>)
- Academic Integrity (<https://bulletin.marquette.edu/policies/academic-integrity/>)
- Academic Misconduct (<https://bulletin.marquette.edu/policies/academic-misconduct-policy/>)
- Academic Program Definitions (<https://bulletin.marquette.edu/policies/academic-programs-defined/>)
- Accelerated Degree Programs (<https://bulletin.marquette.edu/policies/accelerated-degree-programs/>)
- Attendance - Graduate School (<https://bulletin.marquette.edu/policies/attendance/graduate/>)
- Awarding Diplomas and Certificates (<https://bulletin.marquette.edu/policies/awarding-diplomas-certificates/>)
- Background Checks, Drug Testing (<https://bulletin.marquette.edu/policies/background-checks-drug-testing/>)
- Class Rank (<https://bulletin.marquette.edu/policies/class-rank/>)
- Commencement (<https://bulletin.marquette.edu/policies/commencement/>)
- Conferral of Degrees and Certificates (<https://bulletin.marquette.edu/policies/conferral-degrees-certificates/>)
- Course Levels (<https://bulletin.marquette.edu/policies/course-levels/>)

- Credit Hour (<https://bulletin.marquette.edu/policies/credit/>)
- Credit Load - Graduate School (<https://bulletin.marquette.edu/policies/credit-load/graduate/>)
- Faculty Grading (<https://bulletin.marquette.edu/policies/faculty-grading/>)
- Family Education Rights and Privacy Act-FERPA (<https://bulletin.marquette.edu/policies/ferpa/>)
- Grade Appeals (<https://bulletin.marquette.edu/policies/grade-appeals/>)
- Grading System - Graduate School and Graduate School of Management (<https://bulletin.marquette.edu/policies/grading-system/graduate-management/>)
- Graduation - Graduate School (<https://bulletin.marquette.edu/policies/graduation/graduate/>)
- Immunization and Tuberculosis Screening Requirements (<https://bulletin.marquette.edu/policies/immunization-and-tuberculosis-screening/>)
- Last Date of Attendance/Activity (<https://bulletin.marquette.edu/policies/last-dateof-attendance-activity/>)
- Military Call to Active Duty or Training (<https://bulletin.marquette.edu/policies/militarycall-active-duty-training/>)
- Registration - Graduate School (<https://bulletin.marquette.edu/policies/registration/graduate/>)
- Repeated Courses - Graduate School (<https://bulletin.marquette.edu/policies/repeated-courses/graduate/>)
- Student Data Use and Privacy (<https://bulletin.marquette.edu/policies/student-data-use-privacy/>)
- Transcripts-Official (<https://bulletin.marquette.edu/policies/transcripts-official/>)
- Transfer Course Credit - Graduate School (<https://bulletin.marquette.edu/policies/transfer-course-credit-policy/graduate/>)
- Withdrawal - Graduate School (<https://bulletin.marquette.edu/policies/withdrawals/graduate/>)

Graduate School Policies

- Academic Performance (<https://bulletin.marquette.edu/graduate/policies/academic-performance/>)
- Academic Programs Overview (<https://bulletin.marquette.edu/graduate/policies/academic-programs-overview/>)
- Advising (<https://bulletin.marquette.edu/graduate/policies/advising/>)
- Assistantships and Fellowships (<https://bulletin.marquette.edu/graduate/policies/assistantships-andfellowships/>)
- Certificate Concurrent Enrollment (<https://bulletin.marquette.edu/graduate/policies/certificate-concurrent-enrollment/>)
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- Research Involving Humans, Animals, Radioisotopes or Recombinant DNA/Transgenic Organisms (<https://bulletin.marquette.edu/graduate/policies/research-involving-humans-animals-radioisotopes-recombinant-dnatransgenic-organisms/>)
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- Time Limitations (<https://bulletin.marquette.edu/graduate/policies/time-limitations/>)
- Working with Minors (<https://bulletin.marquette.edu/graduate/policies/working-minors/>)

Computer Science Graduate Programs

- Applied Statistics, MS (<https://bulletin.marquette.edu/graduate/applied-statistics-ms/>)
- Bioinformatics, MS (<https://bulletin.marquette.edu/graduate/bioinformatics-ms/>)
- Computer Science, PHD (<https://bulletin.marquette.edu/graduate/computer-science-phd/>)
- Computer and Information Science, MS (<https://bulletin.marquette.edu/graduate/computer-information-science-ms/>)
- Data Science, Certificate (p. 1)
- Data Science, MS (<https://bulletin.marquette.edu/graduate/data-science-ms/>)

COSC 5010 Teaching Computer Science (3 credits)

Historical background, problems, curricular materials and pedagogy in computer science pertinent to the needs of secondary school teachers.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205010>)

COSC 5290 Real-Time and Embedded Systems (3 credits)

Focuses on event-driven programming, real-time scheduling, and synchronization; worst-case execution time analysis and deadline analysis; real-time operating systems and real-time programming languages.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205290>)

COSC 5300 Network Design and Security (3-4 credits)

Focuses on the design and protocols of the upper layers of the Internet architecture, including the TCP/IP protocol suite, packet switching and routing, network programming and applications. Emphasizes related security attacks and defenses, including DNSSEC, TSL, IPsec and the BGP PKI protections. Taught as a lecture only or as a lecture with lab component.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205300>)

COSC 5360 Software and System Security (3 credits)

Fosters comprehension of cybersecurity foundations such as cryptography, operating system security, threat modeling, and secure programming. Develops passion for cybersecurity essential to performance of professional roles as developers, engineers, and managers.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205360>)

COSC 5370 Internet of Things (IoT) (3 credits)

Topics include the definition of IoT, trends in the adoption of IoT, the importance of the IoT in society, the current components of typical IoT devices and trends for the future. Focuses on IoT design considerations, constraints, and interfacing between the physical world and the device. Students are presented with design trade-offs between hardware and software, technologies behind the Internet of Things – RFID, NFC, Wireless networks, WSN, RTLS, GPS, agents, multiagent systems, IoT in retail, NFC applications for the IoT, and IoT in healthcare.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2022 Summer Term, 2021 Summer Term, 2020 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205370>)

COSC 5400 Compiler Construction (3 credits)

Lexical analysis, parsing, code generation and optimization. Includes theoretical foundations and the practical concerns of implementation.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2020 Fall Term, 2019 Spring Term, 2017 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205400>)

COSC 5500 Visual Analytics (3 credits)

Focuses on developing data products using the Javascript/D3 framework by combining concepts from human-computer interaction, visualization and design. Also focuses on model visualization, interpretation, A/B testing and design thinking.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205500>)

COSC 5550 Social and Collaborative Computing (3 credits)

Introduces Social Computing and Computer-Supported Cooperative Work (CSCW). Field includes theory, technology and study of computing systems that support groups of users and facilitate collaboration. Example applications and case studies include email, social networking sites, peer production, crowdsourcing, calendars, scheduling and meeting apps, online dating sites, multiplayer games, discussion forums, instant messaging, collaborative editors and analysis tools.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205550>)

COSC 5600 Fundamentals of Artificial Intelligence (3 credits)

An introduction to the broad field of artificial intelligence. Topics include problem solving by searching, knowledge representation, reasoning, planning, decision making, learning, perception and language processing.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205600>)

COSC 5610 Data Mining (3 credits)

Techniques for extracting and evaluating patterns from large databases. Introduction to knowledge discovery process. Fundamental tasks including classification, prediction, clustering, association analysis, summarization and discrimination. Basic techniques including decision trees, neural networks, statistics, partitional clustering and hierarchical clustering.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205610>)

COSC 5800 Principles of Database Systems (3 credits)

Topics include database concepts and architecture, data modeling, formal query languages such as relational algebra, commercial query language SQL, database access from application programs and a brief examination of advanced concepts including transactions, distributed databases, security and XML.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Summer Term, 2022 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205800>)

COSC 5860 Component-Based Software Construction (3 credits)

Introduction to software components in the context of the object-oriented paradigm. Component development, component selection and adaptation/customization, component deployment and assembly/integration, and system architecture. Industry standards such as JavaBeans, CORBA Component Model, and Microsoft COM/DOM/COM+.

Level of Study: Graduate

Last four terms offered: 2011 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205860>)

COSC 5931 Topics in Computer Science (1-3 credits)

Topics selected from one of the various branches of computer science. Specific topics to be announced in the Schedule of Classes.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%205931>)

COSC 6050 Elements of Software Development (3 credits)

Students explore the software design and development processes through a term project. Concepts covered include: requirements gathering and analysis, mapping requirements to a design, sound coding and documentation practices, configuration management, testing and quality assurance, system deployment and maintenance.

Prerequisite: Programming in a high-level language, knowledge in data structures such as stacks, recursion, queues, trees and graphs.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206050>)

COSC 6051 Professional Software Engineering 1 (3 credits)

Covers software engineering topics typically including: the software development life cycle (SDLC), development methodologies, software quality overview, configuration management, designing for risks and fault tolerance, languages and design, object-oriented programming, observational research and prototyping, requirements, software architectures, operating systems design and real time systems. Offered at General Electric facilities. As this course extends beyond the Marquette term, students receive the grade of IC initially. The IC grade converts to an A-F grade at the completion of the course.

Prerequisite: GE employee in the Software Edison program.

Level of Study: Graduate

Last four terms offered: 2020 Fall Term, 2019 Fall Term, 2018 Spring Term, 2017 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206051>)

COSC 6052 Professional Software Engineering 2 (3 credits)

Covers software engineering topics typically including: systems and communication networks, security and distributed systems, interoperability and standards, design for "ility" (e.g., usability and reliability) and performance, design for parallel processing, embedded systems hardware for software developers, embedded systems software, software design patterns and algorithms. Offered at General Electric facilities. As this course extends beyond the Marquette term, students receive the grade of IC initially. The IC grade converts to an A-F grade at the completion of the course.

Prerequisite: GE employee in the Software Edison program.

Level of Study: Graduate

Last four terms offered: 2020 Fall Term, 2019 Fall Term, 2018 Spring Term, 2017 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206052>)

COSC 6053 Professional Software Engineering 3 (3 credits)

Covers software engineering topics typically including: database systems, decision science, data quality and analytics, user interface design, design for globalization, debugging and troubleshooting, approach, method, implementation and emerging software technologies. Offered at General Electric facilities. As this course extends beyond the Marquette term, students receive the grade of IC initially. The IC grade converts to an A-F grade at the completion of the course.

Prerequisite: GE employee in the Software Edison program.

Level of Study: Graduate

Last four terms offered: 2020 Fall Term, 2019 Fall Term, 2018 Fall Term, 2018 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206053>)

COSC 6054 Professional Software Engineering 4 (3 credits)

Covers design topics related to system design with embedded computing. Topics typically include: design of controls, design for low cost, design for serviceability, design for usability, design for reliability, program management, innovation, requirements management and design thinking. Offered at General Electric facilities. As this course extends beyond the Marquette term, students receive the grade of IC initially. The IC grade converts to an A-F grade at the completion of the course.

Prerequisite: GE employee in the Software Edison program.

Level of Study: Graduate

Last four terms offered: 2020 Fall Term, 2019 Fall Term, 2018 Fall Term, 2017 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206054>)

COSC 6055 Software Quality Assurance (3 credits)

Provides a perspective on people, organizations, controls, processes and tools that collectively influence the success of a Software Quality Assurance (SQA) strategy. Discussion topics include quality approaches as they apply to: requirements, design, release, configuration management, testing, defect management, operations and support. Topics are discussed in the context of a traditional development approach (waterfall, CMMI) and more contemporary models driven by lean and agile practices. Covers considerations specific to implementing an SQA approach within a regulated setting. Approach emphasizes a hands-on view of SQA, thereby providing realistic takeaways to practice in a professional career.

Level of Study: Graduate

Last four terms offered: 2021 Spring Term, 2020 Spring Term, 2019 Spring Term, 2018 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206055>)

COSC 6060 Parallel and Distributed Systems (3 credits)

Students use and develop software for parallel and distributed computing systems. Topics include: job submission and management, tools for parallel and distributed software development, approaches for implementing parallel and distributed computation, parallel and distributed system architectures, and essential evaluation techniques.

Prerequisite: COSC 3100 or equiv.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206060>)

COSC 6090 Research Methods/Professional Development (1 credits)

Designed to introduce the process of research and communication of research in computer science, including presentation and publication of research, preparation of grant proposals, and ethical considerations. May be repeated.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2021 Spring Term, 2020 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206090>)

COSC 6260 Advanced Algorithms (3 credits)

Covers advanced paradigms for the design and analysis of efficient algorithms. Emphasizes fundamental algorithms and advanced methods of algorithmic design, analysis, and implementation. Domains include: string algorithms, network optimization, parallel algorithms, computational geometry, external memory and streaming algorithms, and advanced data structures.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206260>)

COSC 6270 Advanced Operating Systems (3 credits)

Fundamental concepts of operating systems including kernel data structures; process control and scheduling; interprocess communication and synchronization; virtual memory and memory management; mass storage systems and device control; protection and security; and protection and virtualization; evaluation and prediction of performance. Students are expected to spend at least three hours per week gaining hands-on experience in using and modifying a small operating system.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206270>)

COSC 6280 Advanced Computer Security (3 credits)

Symmetric key and public key cryptography, hash functions, random numbers and cryptanalysis; authentication and authorization, password-based security, ACLs and capabilities, covert channels, security models, firewalls and intrusion detection systems; authentication protocols, session keys, SSH, SSL, IPsec, Kerberos, WEP, and GSM; flaws and malware, buffer overflows, viruses and worms, malware detection, software reverse engineering, digital rights management, secure software development and operating systems security; fundamentals about bitcoin and cryptocurrency technologies. Students write programs for assignments using the C programming language.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206280>)

COSC 6330 Advanced Machine Learning (3 credits)

Provides a graduate-level introduction to machine learning and statistical pattern recognition and in-depth coverage of new and advanced methods in machine learning, as well as their underlying theory. Emphasizes approaches with practical relevance and discusses a number of recent applications of machine learning, such as data mining, computer vision, robotics, text and web data processing. An open research project is a major part of the course.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206330>)

COSC 6340 Component Architecture (3 credits)

Focuses on designing and implementing software components, and streamlining the translation from business intent into realized application behavior in a practical hands-on, business-based environment. Introduces service-oriented architecture (SOA) and principles such as loose coupling, abstraction, reusability, autonomy, statelessness, discoverability, interoperability and composability.

Level of Study: Graduate

Last four terms offered: 2016 Spring Term, 2011 Fall Term, 2010 Spring Term, 2008 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206340>)

COSC 6345 Mobile Health (mHealth) (3 credits)

Offers a multidisciplinary overview of the emerging technologies used in mobile health (mHealth). Research and innovations in this area promise solutions to the need for broader access to affordable and effective healthcare by enabling consumers and their caregivers to take charge of their health and well-being. mHealth is the provision of health information and services using sensor data via mobile phones and tablets. Students develop foundational knowledge of understanding the behaviors, different data models, security and privacy issues.

Level of Study: Graduate

Last four terms offered: 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206345>)

COSC 6350 Distributed Computing (3 credits)

Introduces a broad spectrum of topics encompassing system architecture, software abstractions, distributed algorithms and issues pertaining to distributed environments such as replication, consistency, fault tolerance, transactions and security.

Level of Study: Graduate

Last four terms offered: 2014 Spring Term, 2012 Spring Term, 2009 Spring Term, 2007 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206350>)

COSC 6355 Mobile Computing (3 credits)

Focuses on the fundamentals of mobile computing, challenges in mobile computing, mobility management and mobile data management. Also focuses on context awareness and wireless communications, ubiquity of wireless communication technologies and standards, seamless access network services and resources from anywhere, at anytime, middleware for mobile computing, operation systems, programming languages, network protocols and security aspects of mobile computing. Explores concepts in sensor networks, including operating systems, programming languages, network protocols and programming models.

Prerequisite: COSC 2100 or equiv.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2021 Summer Term, 2020 Summer Term, 2019 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206355>)

COSC 6360 Enterprise Architecture (3 credits)

Focuses on key topics and concepts that represent enterprise architecture (EA). Addresses the people, process and technology elements of EA from both a business and technical perspective. Explores the background, history, planning, governing, maintaining and common methodologies associated with EA. Prototypes some of the technology used in enterprises today to gain a better understanding of how information is represented, systems are integrated and standards are put into practice.

Level of Study: Graduate

Last four terms offered: 2021 Fall Term, 2020 Fall Term, 2019 Fall Term, 2018 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206360>)

COSC 6375 Web Technologies (3 credits)

Exposes students to design and architectural principles in developing web applications. Focuses on the client side, middleware and service layer of web applications. Topics range from HTML, JavaScript, JQuery, Java Servlets, MVC Design Pattern, Java Spring MVC, SQL, JDBC, Hibernate, AngularJS and Cloud Computing.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206375>)

COSC 6380 Big Data Systems (3 credits)

Focuses on newer, advanced database techniques in the areas of Big Data, NoSQL, Hadoop and Apache Spark. Covers main NoSQL data management topics such as document databases, key-value stores and graph databases.

Prerequisite: Database Systems or equiv.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206380>)

COSC 6390 Professional Seminar in Computing (1 credits)

Topic to be chosen each term from among issues important to all professionals in computing. All students specifically in the computing program are expected to participate for the fall and spring terms, and one of the two summer terms. S/U grade assessment.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206390>)

COSC 6500 Foundations of Computing (7 credits)

Presents the breadth and current status of computer science in our computerized society and the fundamentals of professional knowledge, skills and abilities. Foundational topics are intermixed with study of software development which include an introduction to abstraction, algorithmic thinking, simulation and testing for computer-based problem solving using higher-level programming languages. Algorithm analysis and computational complexity are presented in the context of considering data structures, algorithms and alternatives. Students program exercises using graphical user interfaces, data base connections, parallel computing and interfaces to the World Wide Web (WWW). Experience includes using an interactive development environment, studying software development methodology, and testing code, basic system administration, computer networking and operating system configuration.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206500>)

COSC 6510 Data Intelligence (3 credits)

Foundational topics in data intelligence. Includes properties and benefits for data intelligence and methodology for the development of data intelligence solutions. Examines technology employed for managing data and creating visualizations and dashboards. Topics include developing a business case, evaluating performance and managing data. Presents overview of data architectures commonly used in data intelligence solutions and includes exercises using common techniques for prediction and time series analysis.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206510>)

COSC 6520 Data Analytics (3 credits)

Foundational topics in the analysis of data. Includes methodology for the development of data analytics systems. Examines technology employed for data analytics in a variety of industry segments and the benefits derived from data analytics. Foundations of text and data mining techniques commonly used for classification, clustering and prediction. Students are presented techniques for developing a business case, evaluating predictive performance and managing data. Includes exercises using analytic technology and a project to apply analytics to a customer application. Students without programming experience are advised to complete COSC 6510 Data Intelligence before attempting COSC 6520.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206520>)

COSC 6530 Concepts of Data Warehousing (3 credits)

Provides an introduction to data warehouse design. Reviews topics in data modeling, database design and database access. Data warehouse planning, design, implementation and administration. The role of data warehouse in supporting decision support systems (DSS), business intelligence and business analytics.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206530>)

COSC 6550 Introduction to Cybersecurity (3 credits)

Provides an introduction to cybersecurity threats, methods and security techniques. Foundations of various cybersecurity frameworks and methods for applying them to different types of organizations. Includes cyber threat environment, along with methods, tools and techniques that can help mitigate vulnerabilities and reduce risks to an organization.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206550>)

COSC 6560 Principles of Service Management and System Administration (3 credits)

Introduction to the concepts, principles and practices involved in the operations of secure computing systems. Presents principles of service management and explores how the principles of system administration are derived from concepts of delivering quality services. Lab exercises performing rudimentary tasks of a system administrator using virtual machine environments. Foundation topics include: cryptography, popular operating systems for servers, network configuration, system components, networked systems, host management, user management, configuration of servers and services, incident management, change management, security, monitoring and analysis of operations.

Prerequisite: Basic knowledge of scripting, operating systems and services.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206560>)

COSC 6570 Data at Scale (3 credits)

Combines ideas from parallel databases, distributed systems and programming languages to analyze data at scale. Relevant technologies are introduced and taught in an accessible and inclusive way. Some examples include cloud computing, SQL and NoSQL databases, MapReduce ecosystem, Spark and its contemporaries and graph databases.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206570>)

COSC 6580 Data Security and Privacy (3 credits)

Focuses on fundamental and advanced topics in data security and privacy, including differential privacy, secure multi-party computation, homomorphic encryption, data perturbation, data anonymization, security and privacy in AI, location privacy, and social network privacy. Students also learn practical skills via projects.

Prerequisite: Basic knowledge on statistics, databases, machine learning/data mining, and distributed systems.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206580>)

COSC 6820 Data Ethics (3 credits)

A comprehensive overview of the current ethical and social implications of our data-driven society. A sociotechnical approach is used to unpack issues of privacy and surveillance, algorithmic biases, fairness, transparency, and accountability across various contexts.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2022 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206820>)

COSC 6931 Topics in Computer Science (3 credits)

Topics vary. Students may enroll more than once as the subject matter changes.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Summer Term, 2022 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206931>)

COSC 6960 Seminar in Computer Science (1-3 credits)

Seminar topics selected from one of the various branches of computer science. Specific topics to be announced in the Schedule of Classes.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206960>)

COSC 6964 Practicum for Research and Development in Computing (3-6 credits)

S/U grade assessment. Available only to full-time students. Cons. of the computing dir. of graduate studies or cons. of dept. ch.

Prerequisite: 3.00 MU GPA; must be enrolled in Plan B option of the M.S. in computing program and have completed at least 15 credit hours earned in graduate (6000-level) courses.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206964>)

COSC 6965 Curriculum Integrated Practicum in Computing (1-2 credits)

Involves practical application of the knowledge and skills being studied concurrently, and previously studied, in other course work for computing professionals.

Prerequisite: Admission to the COMP program's integrated practicum option; cons. of the computing dir. of graduate studies or cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2022 Spring Term, 2021 Fall Term, 2021 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206965>)

COSC 6974 Practicum for Research and Development in Computer Science (1-6 credits)

Students in the MS in Computing program should be registering for COSC 6964, Practicum for Research and Development in Computing. S/U grade assessment.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Summer Term, 2022 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206974>)

COSC 6975 Curriculum Integrated Practicum in Computer Science (0 credits)

Involves advancing practical research and development of the computer science doctoral program student.; cons. of the co-op chair or grad. chair or dept. chair.

Prerequisite: Admitted to the COSC-PHD prog.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206975>)

COSC 6995 Independent Study in Computer Science (1-6 credits)

An in-depth study on a topic or subject matter usually not offered in the established curriculum with faculty and independent of the classroom setting.

Prerequisite: Cons. of instr. and cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206995>)

COSC 6998 Professional Project in Computer Science (0 credits)

SNC/UNC grade assessment.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Fall Term, 2021 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206998>)

COSC 6999 Master's Thesis (1-6 credits)

S/U grade assessment.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Fall Term, 2021 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%206999>)

COSC 8995 Independent Study in Computer Science (1-3 credits)

A doctorate level in-depth research on a topic or subject matter usually not offered in the established curriculum with faculty and independent of the classroom setting.

Prerequisite: Cons. of instr. and cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%208995>)

COSC 8999 Doctoral Dissertation (1-12 credits)

S/U grade assessment.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%208999>)

COSC 9970 Graduate Standing Continuation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as less than half-time status only, cannot be used in conjunction with other courses, and does not qualify students for financial aid or loan deferment.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209970>)

COSC 9974 Graduate Fellowship: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209974>)

COSC 9975 Graduate Assistant Teaching: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209975>)

COSC 9976 Graduate Assistant Research: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2021 Spring Term, 2020 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209976>)

COSC 9987 Doctoral Qualifying Examination Preparation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week toward their doctoral qualifying exam.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2021 Spring Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209987>)

COSC 9988 Doctoral Qualifying Examination Preparation: Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2022 Spring Term, 2021 Fall Term, 2021 Spring Term, 2020 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209988>)

COSC 9989 Doctoral Qualifying Examination Preparation: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209989>)

COSC 9991 Professional Project Continuation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their professional project. Any professional project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209991>)

COSC 9992 Professional Project Continuation: Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their professional project. Any project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209992>)

COSC 9993 Professional Project Continuation: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their professional project. Any professional project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209993>)

COSC 9994 Master's Thesis Continuation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2020 Summer Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209994>)

COSC 9995 Master's Thesis Continuation: Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209995>)

COSC 9996 Master's Thesis Continuation: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209996>)

COSC 9997 Doctoral Dissertation Continuation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209997>)

COSC 9998 Doctoral Dissertation Continuation: Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2021 Fall Term, 2020 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209998>)

COSC 9999 Doctoral Dissertation Continuation: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=COSC%209999>)