CS-583 - Analysis of Algorithms

Master of Science in Computer Science

Course Information

Course Section: CS583-001, CS583-002

Course Term: Summer 2022

PROGRAM OBJECTIVES

After completing the program, students will demonstrate an ability to:

1) **Foundations of Computer Science**: apply mathematical foundations and algorithmic principles in the modeling and design of computing systems.
2) **Computer Systems Fundamentals**: apply fundamental concepts in computer systems to model, design, and implement a computer-based system, process, or program that meets desired needs.
3) **Information Processing Fundamentals**: apply fundamental concepts in information processing to model, design, and implement a computer-based system, process, or program that meets desired needs.
4) **Advanced Computer Systems**: use advanced concepts in computer systems to design, implement, and evaluate a computer-based system, process, component, or program.
5) **Advanced Information Processing**: use advanced information processing concepts to design, implement, and evaluate a computer-based system, process, component, or program.

COURSE DESCRIPTION

Analyzes computational resources for important problem types by alternative algorithms and their associated data structures, using mathematically rigorous analysis techniques. Specific algorithms analyzed and improved. This course introduces basic algorithm design and analysis techniques, including asymptotic analysis, divide-and-conquer techniques, probabilistic analysis and randomized algorithms, sorting algorithms and order statistics, greedy algorithms, dynamic programming approaches, amortized analysis, flow algorithms, NP-hardness, and introduction to approximation algorithms, etc. Classic algorithms are introduced, and they are analyzed mathematically and rigorously.

COURSE METHODOLOGY

This is a foundational skills course. Each week, learners will:

- study various algorithm and analysis techniques,
- observe the instructor working through techniques and examples
- practice and check their understanding via additional Solved Examples, then
- complete an assignment as evidence of knowledge and skills gained.

The course summative assessment is a final exam.

COURSE OBJECTIVES

After completing the course, learners will be able to:

- Understand classical problems in Computer Science.
- Understand classical algorithm design and analysis strategies.
- Analyze the computability of a problem.
- Design and analyze new algorithms to solve a computational problem.

GEORGE MASON UNIVERSITY

- Reason algorithmically.

Instructor Information

Refer to the Blackboard course shell for section-specific instructor contact, biography, and office hours information.

Course Resources

TEXTBOOKS AND READINGS

REQUIRED

- **Textbook**:
  - Title: Introduction to Algorithms, Third Edition
  - Author(s): Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 2009
  - ISBN-13: 978-0262033848
- **ZyBook**: Interactive, digital textbook.
  - Access is provided in the Blackboard course in the Student Resources area.

COMPUTER REQUIREMENTS

HARDWARE

You will need access to a Windows or Macintosh computer with at least 2 GB of RAM and to a fast, reliable broadband Internet connection (e.g., cable, DSL). For optimum visibility of course material, the recommended computer monitor and laptop screen size is 13-inches or larger. You will need computer speakers or headphones to listen to recorded content. A headset microphone is recommended for live audio sessions using course tools like Blackboard Collaborate. For the computer hard disk space required to take an online course, consider and allow for the space needed to:

- Install the required and recommended software.
- Save your course assignments.

For hardware and software purchases, visit Patriot Computers.

You are strongly encouraged to back up all contents of your computer on a regular basis. Loss of data will not excuse late or unsubmitted assignments.

SOFTWARE

Software applications include the following:

- Web browser (See Blackboard Support for supported web browsers)
- Adobe Acrobat Reader (free download)
- Flash Player (free download)
- Microsoft Office (purchase)
- Blackboard Collaborate (select from the course menu)

UPDATING YOUR COMPUTER

Please be sure to update your computer and prepare yourself to begin using the online format BEFORE the first day of class.

Grading Information

GRADING SCALE

The following table describes the grading system:

GRADE	PERCENTAGE
A	94 and above
A-	90 – 93
B+	87 – 89
B	84 – 86
B-	80 – 83
C	70 – 79
F	Less than 70

LETTER GRADING DESCRIPTIONS:

Listed below are grades and academic standards for each grade awarded.

- **A:** Consistently performs above and beyond the course/assignment requirements
- **B:** Meets and occasionally exceeds the course/assignment requirements
- **C:** Minimally meets the course/assignment requirements
- **F:** Fails to meet the course/assignment requirements

CATEGORIES AND WEIGHTS

The following table lists the types of graded activities in this course and each category's weight in the final course grade.

ASSIGNMENT CATEGORY	% OF OVERALL COURSE GRADE
11 Assignments *(All assignments have the same weight. The lowest scoring assignment will be excluded for the final course grade.)*	60%
Final Exam	40%
TOTAL:	**100%**

LATE ASSIGNMENTS

Late assignments are **not** accepted – *they will be given a score of 0 points*.

ASSIGNMENTS 60%
In each week, you will be required to submit an assignment. Submit all assignments via Blackboard. For each assignment, review the corresponding assignment page in Blackboard for detailed instructions.

Corrections and resubmissions of assignments are permitted. Do not copy-and-paste from external sources or each other when submitting results (all assignments are checked for plagiarism). In programming exercises, include working code.

Assignments are due the **Monday** of the **following** Module **11:59 PM, ET** unless otherwise stated. See the Table in the section `Course Topics'.

FINAL EXAM 40%
The final exam is open-book and open-note. You may use your own notes, the textbook, and information from this course. You may **NOT** use any notes or solutions from the internet or current or past students. The exam comprises 10 randomly selected questions from the topics covered in this course.

The exam will be available to take during the last week (Module 13) of the class. Your instructor will communicate exact dates and times.

Final Exam: Date: August 12, 2022. Time: 7:00pm-10:00pm

Policies and Services

MASON HONOR CODE

To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set forth this honor code:

Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.

You are expected to familiarize yourself with and adhere to the Honor Code. Student members of the George Mason University community pledge not to cheat, plagiarize, steal, and/or lie in matters related to academic work.

For additional important information, including the Honor Code definitions of cheating, plagiarism, stealing, and lying, see the George Mason University Academic Integrity page.

All work performed in this course will be subject to Mason's Honor Code.

ACADEMIC INTEGRITY EXPECTATIONS

1. Working online requires dedication and organization. Proper preparation is expected every week. You are expected to log in to the course each week and complete the assignments and activities on or before the due dates.
2. Students must check their GMU email messages on a daily basis for course announcements, which may include reminders, revisions, and updates.
3. It is expected that you will familiarize yourself with and adhere to the Honor Code. Student members of the George Mason University community pledge not to cheat, plagiarize, steal, and/or lie in matters related to academic work.
4. It is essential that you promptly communicate any questions or problems to the instructor.

INDIVIDUALS WITH DISABILITIES

The university is committed to providing equal access to employment and educational opportunities for people with disabilities.

Mason recognizes that individuals with disabilities may need reasonable accommodations to have equally effective opportunities to participate in or benefit from the university educational programs, services, and activities, and have equal employment opportunities. The university will adhere to all applicable federal and state laws, regulations, and guidelines with respect to providing reasonable accommodations as necessary to afford equal employment opportunity and equal access to programs for qualified people with disabilities.

Applicants for admission and students requesting reasonable accommodations for a disability should call the Office of Disability Services at 703-993-2474. Employees and applicants for employment should call the Office of Equity and Diversity Services at 703-993-8730. Questions regarding reasonable accommodations and discrimination on the basis of disability should be directed to the Americans with Disabilities Act (ADA) coordinator in the Office of Equity and Diversity Services.

EMAIL POLICY

Web: masonlive.gmu.edu

Mason uses electronic mail to provide official information to students. Examples include notices from the library, notices about academic standing, financial aid information, class materials, assignments, questions, and instructor feedback.

Students are responsible for the content of university communication sent to their Mason e-mail account and are required to activate that account and check it regularly.

Students are also expected to maintain an active and accurate mailing address in order to receive communications sent through the United States Postal Service

ADDITIONAL SERVICES AND POLICIES

UNIVERSITY POLICIES
Students must follow the university policies. See University Policies.

DIVERSITY
George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

RESPONSIBLE USE OF COMPUTING
You are expected to adhere to the university policy for Responsible Use of Computing. See University Policies/Computing.

STUDENTS WITH DISABILITIES
Students with disabilities who seek accommodations in a course must be registered with the George Mason University Office of Disability Services (ODS) and inform their instructor, in writing, at the beginning of the semester.

UNIVERSITY LIBRARIES
University Libraries provides Library services for distance students.

WRITING CENTER
The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing.

You can now sign up for an Online Writing Lab (OWL) session just as you may sign up for a face-to-face session in the Writing Center, which means YOU set the date and time of the appointment.

COUNSELING AND PSYCHOLOGICAL SERVICES (CAPS)
The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance.

FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (FERPA)
The Family Educational Rights and Privacy Act of 1974 (FERPA), also known as the "Buckley Amendment," is a federal law that gives protection to student educational records and provides students with certain rights.

Course Topics

Refer to the table below for a summary of the Modules, Topics, and Activities included in this course. Refer to the "Syllabus and Course Schedule" area of the course in Blackboard for a list of which Modules are covered in which weeks as well as assignment due dates.

MODULE	TOPICS AND ACTIVITIES	GRADED ASSIGNMENTS
Module 01 **Introduction and growth of functions** **May 23, 2022-May 27, 2022**	**Topics** • Asymptotic Notation • Standard Notations And Common Functions **Activities** • Solved Exercises	**Assignments** • Assignment #1 - Relative Asymptotic Growths • Released on May 23, 2022 • Due on May 30, 2022
Module 02 **Divide and conquer** **May 30, 2022-June 3, 2022**	**Topics** • The Maximum-Subarray Problem • Matrix Multiplication • Substitution Method For Solving Recurrence • Master Method For Solving Recurrence **Activities** • Solved Exercises	**Assignments** • Assignment #2 - Divide and Conquer • Released on May 30, 2022 • Due on June 6, 2022
Module 03 **Sorting algorithms and order statistics** **June 6, 2022-June 10, 2022**	**Topics** • Radix sort • Bucket sort • Quickselect • Quicksort And Its Analysis - Part 1 • Quicksort And Its Analysis - Part 2 • Lower Bounds For Sorting • Minimum And Maximum • Selection In Expected Linear Time • Selection In Worst-Case Linear Time **Activities** • Solved Exercises	**Assignments** • Assignment #3 - Medians and Order Statistics • Released on June 6, 2022 • Due June 13, 2022
Module 04 **Probabilistic analysis and randomized algorithms** **June 13, 2022-June17,2022**	**Topics** • The Hiring Problem And Indicator Random Variables • Randomized Algorithms • The Online Hiring Problem **Activities** • Solved Exercises	**Assignments** • Assignment #4 - Randomized Algorithms • Released on June 13, 2022 • Due on June 20, 2022

MODULE	TOPICS AND ACTIVITIES	GRADED ASSIGNMENTS
Module 05 **Dynamic programming** **June 20, 2022-June 24, 2022**	**Topics** • Dynamic programming • Rod Cutting • Matrix-Chain Multiplication • Elements Of Dynamic Programming **Activities** • Solved Exercises	**Assignments** • Assignment #5 - Dynamic Programming • Released on June 20, 2022 • Due on June 27, 2022
Module 06 **Greedy algorithms** **June 27, 2022-July 1, 2022**	**Topics** • Huffman compression • Greedy algorithms • An Activity-Selection Problem • Elements Of The Greedy Strategy **Activities** • Solved Exercises	**Assignments** • Assignment #6 - Greedy Algorithms • Released on June 27, 2022 • Due on July 5, 2022
Module 07 **Amortized Analysis** **July 5, 2022-July 8, 2022**	**Topics** • Aggregate Analysis • The Accounting Method • The Potential Method • Dynamic Tables **Activities** • Solved Exercises	**Assignments** • Assignment #7 - Amortized Analysis • Released July 5, 2022 • Due on July 11, 2022
Module 08 **Graph algorithms** **July 11, 2022-July 15, 2022**	**Topics** • Graph representations: Adjacency lists • Graph representations: Adjacency matrices • Graphs: Breadth-first search • Graphs: Depth-first search • Topological sort • Strongly Connected Components **Activities** • Solved Exercises	**Assignments** • Assignment #8 - Elementary Graph Algorithms • Released on July 11, 2022 • Due on July 18, 2022
Module 09 **Minimum spanning tree** **July 18, 2022-July 22, 2022**	**Topics** • Minimum spanning tree • The Prim's Algorithm **Activities** • Solved Exercises	**Assignments** • Assignment #9 - Minimum Spanning Tree • Released on July 18, 2022 • Due on July 25, 2022

MODULE	TOPICS AND ACTIVITIES	GRADED ASSIGNMENTS
Module 10 **Single-source shortest path** **July 25, 2022-July 29, 2022**	**Topics** • Algorithm: Dijkstra's shortest path • Algorithm: Bellman-Ford's shortest path • Single-Source Shortest Paths In Directed Acyclic Graphs • Proofs Of Shortest-Paths Properties **Activities** • Solved Exercises	**Assignments** • Assignment #10 - Single-Source Shortest Paths • Released on July 25, 2022 • Due on August 1, 2022
Module 11 **All pairs shortest paths** **August 1, 2022-August 5, 2022**	**Topics** • All pairs shortest path • Shortest Paths And Matrix Multiplication • Johnson's Algorithm For Sparse Graphs **Activities** • Solved Exercises	**Assignments** • Assignment #11 - All-Pairs Shortest Paths • Released on August 1, 2022 • Due on August 8, 2022
Module 12 **Maximum flows** **August 8, 2022-August 10, 2022**	**Topics** • Flow Networks • The Ford-Fulkerson Method • Maximum Bipartite Matching **Activities** • Solved Exercises	
Module 13 **Final Exam** **August 12, 2022** **Time: 7:00pm-10:00pm**	**Topics** • Final Exam **Activities** • Final Exam	**Assignments** • Final Exam • **Time: 7:00pm-10:00pm**