

CSC 415 Analysis of Algorithms

3 cr.

Instructor: TBA
email: TBA@salemstate.edu

Office: location
Office Hours: days and times

Phone: (978) 542-extension

Section	Time	Room	Final Exam
nn	days and times	location	date and time

Catalog description:

Advanced concepts from data structures and general algorithms are discussed from both theoretical and applied viewpoints. Topics covered include: multi-lists, graph theory, searching and sorting algorithms, and general n-way tree structures. Techniques for analysis of algorithms for average and best/worst cases are presented. Laboratory work may involve programming in a high-level language. Three lecture hours per week.

Prerequisites: CSC 260 and MAT 214A.

Goals:

The aims of this course are:

- CG01: to present a coherent view of algorithms encountered in earlier courses;
- CG02: to introduce a selection of more advanced algorithms;
- CG03: to present common tools and techniques for assessing the costs and complexity of algorithms.

Objectives:

Upon completion of the course, the student will have demonstrated the ability to:

- CO01: perform best case, worst case, and average case analysis of selected algorithms for managing lists, trees, heaps, and hash tables;
- CO02: explain and analyze examples of greedy algorithms, such as Huffman codes;
- CO03: explain and use the main ideas of probabilistic and amortized analysis;
- CO04: explain the analysis and use of breadth-first and depth-first search, minimum spanning trees, and shortest-path algorithms;
- CO05: understand and use introduced algorithms in such applications as string matching, computational geometry, dynamic programming, and graphs.

Program Outcome vs. Course Objectives matrix

Program Objective (condensed form)	CO01	CO02	CO03	CO04	CO05
PO-A: apply knowledge of computing and math	✓	✓	✓	✓	✓
PO-B: analyze a problem and define its computing requirements	✓	✓	✓	✓	✓
PO-C: design, implement and evaluate applications			✓	✓	✓
PO-D: function effectively in teams to accomplish a common goal					
PO-E: professional, ethical, and social responsibilities					
PO-F: communicate effectively with a range of audiences					
PO-G: local and global impact of computing on people and society					
PO-H: need for continuing professional development					

Program Objective (condensed form)	CO01	CO02	CO03	CO04	CO05
PO-I: use current techniques, skills, and tools	✓	✓	✓	✓	✓
PO-J: apply theory and principles to model and design systems	✓	✓	✓	✓	✓
PO-K: apply design and development principles in constructing software	✓			✓	✓
note - full statements of the Program Outcomes (program objectives) for the Computer Science Major can be found in the document <i>Computer Science Major Program Educational Objectives and Program Outcomes</i> on the Assessment page of the Computer Science Major (cs.salemstate.edu)					

Topics:

- brief review of course programming language (as appropriate)
- mathematical tools for algorithm analysis **DS3(3), DS4(3)**
 - limits and big-O notation
 - summation formulas
 - recursion relations
 - generating functions
- numeric algorithms (Fibonacci numbers, polynomial arithmetic, Fast Fourier Transform, etc.) **AL3(20)**
- analysis of searching and sorting algorithms
 - finding largest (or smallest), second largest, etc.
 - linear search, binary search
 - insertion sort, quicksort, merge sort, tree sort, heap sort
- multi-lists
- tree structures
 - general trees
 - n-way trees
 - balancing algorithms
 - traversal algorithms
 - expression trees
- review of basic hashing techniques
- advanced fast-access algorithms
- graphs, their representations, and traversal algorithms **AL3(5)**
 - graph representation
 - elementary graph algorithms
 - minimum spanning trees
 - shortest-path algorithms
- pattern matching and string algorithms **AL2(3)**
- dynamic programming AL8(2)
- geometric algorithms AL8(2)
- computational complexity, NP-completeness AL6(2)

Assignments and Examination:

The primary emphasis of this course is on the understanding of a set of algorithms with wide-ranging applicability, together with their costs, advantages, and disadvantages. Each algorithm is presented and discussed in detail, including classic analysis to determine best, average, and worst-case performance. Implementation considerations will be touched on, along with proper solution development. Algorithms may be assigned for implementation in programming projects which will include analysis of time and space costs. (Possible programming assignments: creation and evaluation of expression trees; balancing algorithms; breadth-first vs. depth-first graph traversal; hashing, graph algorithms, pattern matching algorithms, and geometric algorithms.) There will be periodic written homework assignments on the major topics of the course.

The course grade will be determined using the following approximate weights: programming projects- 40%, written homework - 30%, final examination - 30%

Course Objective / Assessment Mechanism matrix

	Programming Projects	Written Homework	Final Examination
CO01	✓	✓	✓
CO02		✓	✓
CO03		✓	
CO04	✓	✓	✓
CO05	✓	✓	✓

Bibliography:

[Mathematical background]

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Heineman, George T.; Pollice, Gary, Selkow, Stanley. **Algorithms in a Nutshell.** O'Reilly Media, 2008.

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McConnell, Jeffrey. **Analysis of Algorithms.** Second Edition. Jones & Bartlett, 2008.

Moret, B. M. E.; Shapiro, H. D. **Algorithms from P to NP, Volume I: Design and Efficiency.** Benjamin/Cummings, 1991.

Purdum, Paul Walton, Jr.. **The Analysis of Algorithms** Oxford University Press, 2004.

Rawlins, Gregory J. E. **Compared to What? An Introduction to the Analysis of Algorithms.** Computer Science Press W. H. Freeman, 1992.

Sedgewick, Robert. **Algorithms. Fourth Edition.** Addison-Wesley, 2011.

Part 5. Third Edition. Addison-Wesley, 2002.

Sedgewick, Robert. **Algorithms in Java, Parts 1-4. Third Edition.** Addison-Wesley, 2001.

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Skiena, Steven S.; Revilla, Miguel. **The Algorithm Design Manual. Second Edition.** Springer, 2010.

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Smith, Jeffrey D. . **Design and Analysis of Algorithms.** PWS-Kent, 1989.

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"Salem State University assumes that all students come to the University with serious educational intent and expects them to be mature, responsible individuals who will exhibit high standards of honesty and personal conduct in their academic life. All forms of academic dishonesty are considered to be serious offences against the University community. The University will apply sanctions when student conduct interferes with the University primary responsibility of ensuring its educational objectives." Consult the University catalog for further details on Academic Integrity Regulations and, in particular, the University definition of academic dishonesty.

The Academic Integrity Policy and Regulations can be found in the University Catalog and on the University website (http://catalog.salemstate.edu/content.php?catoid=13&navoid=1295#Academic_Integrity). The formal regulations are extensive and detailed - familiarize yourself with them if you have not previously done so. A concise summary of and direct quote from the regulations: "Materials (written or otherwise) submitted to fulfill academic requirements must represent a student's own efforts". *Submission of other's work as one's own without proper attribution is in direct violation of the University's Policy* and will be dealt with according to the University's formal Procedures. *Copying without attribution is considered cheating in an*

*academic environment - simply put, **do not do it!***

University-Declared Critical Emergency Statement:

In the event of a university-declared emergency, Salem State University reserves the right to alter this course plan. Students should refer to www.salemstate.edu for further information and updates. The course attendance policy stays in effect until there is a university-declared critical emergency.

In the event of an emergency, please refer to the alternative educational plans for this course, which will be distributed via standing class communication protocols. Students should review the plans and act accordingly. Any required material that may be necessary will have been previously distributed to students electronically or will be made available as needed via email and/or Internet access.

Equal Access Statement:

"Salem State University is committed to providing equal access to the educational experience for all students in compliance with Section 504 of The Rehabilitation Act and The Americans with Disabilities Act and to providing all reasonable academic accommodations, aids and adjustments. **Any student who has a documented disability requiring an accommodation, aid or adjustment should speak with the instructor immediately.** Students with Disabilities who have not previously done so should provide documentation to and schedule an appointment with the Office for Students with Disabilities and obtain appropriate services."

Note: This syllabus represents the intended structure of the course for the semester. If changes are necessary, students will be notified in writing and via email.