

Course contents. The B503 course will cover the following topics in order. (Each topic is preceded by the section number of the text book that covers the topic.)

Chapter 1 Introduction

- 1.1 Straight-Line Programs
- 1.2 Simple Loops
 - 1.2.1 Horner's Method
- 1.3 Numbers
 - 1.3.1 Integer Value
- 1.4 Division: Quotients and Remainders
 - 1.4.1 Addition
 - *1.4.2 Arithmetic Modulo n
 - *1.4.3 The Euclidean Algorithm
- 1.5 Exponents and Logarithms
 - 1.5.1 Binary Search
- 1.6 Simple Nested Loops
 - 1.6.1 Matrix Addition
 - 1.6.2 Multiplication
 - 1.6.3 Matrix Multiplication
 - 1.6.4 Shortest Path
- 1.7 Linear Sums
 - 1.7.1 Triangular Matrix Addition
- 1.8 Probability
 - 1.8.1 Combining Probabilities
 - 1.8.2 Conditional Probabilities
- 1.9 Average Case and Worst Case
 - 1.9.1 Insertion Sort
- 1.10 Big O Notation and Limits
- *1.11 Relations and Orderings
- 1.12 Proof by Induction
 - *1.12.1 Induction with Well-Orderings
 - *1.12.1.1 Binary Merge—Part 1
 - *1.12.1.2 Binary Merge—Part 2
 - *1.12.2 Noetherian Induction

Chapter 2 Summing Series

- 2.1 Summation Notation
 - 2.1.1 Linear Searching
 - *2.1.2 Infinite Sums
 - *2.1.3 Conventions
- 2.2 Operators
- 2.3 Polynomial Sums
 - 2.3.1 Quicksort
- 2.4 Exponential Sums
 - 2.4.1 Random Hashing
- 2.5 Summation by Parts
 - 2.5.1 Cumulative Probabilities
 - 2.5.2 Heap Sorting
 - 2.5.3 Random Hashing (Variance)
- 2.6 Fractional Sums
 - *2.6.1 Finding Partial Fraction Decompositions
- *2.7 Derivatives and Integrals of Sums

Chapter 3 Products and Binomials

- 3.1 Factorials
 - 3.1.1 Permutations
 - 3.1.2 Anagrams
 - 3.1.3 Nonrepeating Random Hashing
 - *3.1.4 The Gamma Function
- 3.2 Binomials
 - 3.2.1 Relations among Binomials
 - 3.2.2 Strategies for Summation Formulas
 - 3.2.3 Coin Flipping
 - 3.2.4 Nonrepeating Hashing
- †3.3 Multiple Sums
 - 3.3.1 Hashing with Chaining
- 3.4 Periodic Terms
 - 3.4.1 Complex Numbers
 - *3.4.2 General Formula
- 3.5 Products of Binomials
- 3.6 Multinomial Coefficients
- *3.7 Stirling Numbers
 - *3.7.1 Find the Maximum
- *3.8 Hypergeometric Functions
- *3.9 Inclusion and Exclusion

Chapter 4 Asymptotic Approximation

- 4.1 Bounding Functions
 - 4.1.1 Resource Trade-offs
- †4.2 Asymptotic Notation
 - †4.2.1 Power Series
 - †4.2.2 Techniques for Asymptotic Expansions
 - *4.2.3 Asymptotics and Convergence
- 4.3 Bounding Summations
 - *4.3.1 Backtracking
 - *4.3.1.1 Backtracking (Average Time)
- 4.4 Rapidly Changing Summands
- 4.5 Slowly Varying Summands
 - 4.5.1 The Euler Summation Formula
 - *4.5.2 The Generalized Euler Summation Formula
 - *4.5.3 Functions with Slowly Varying Tails
 - †4.5.4 Harmonic Numbers
 - †4.5.4.1 Random Hashing—Finding Items
 - †4.5.5 Stirling's Approximation
- 4.6 Alternating Summands
- *4.7 Asymptotic Iteration
- *4.8 Asymptotics and Measurements

Chapter 5 Simple Linear Recurrences

- 5.1 Notation
- 5.2 Linear First Order Recurrences
 - 5.2.1 Secondary Recurrences
 - 5.2.2 Divide and Conquer Algorithms
 - 5.2.3 Faster Multiplication
 - 5.2.3.1 Break-even Points
 - 5.2.4 Quicksort (Best Case)

- 5.2.5 Strassen's Algorithm
- 5.3 Generating Functions
 - 5.3.1 Fibonacci Numbers
 - 5.3.2 Properties of Fibonacci Numbers
 - *5.3.3 Tape Sorting: Three Tapes
 - *5.3.3.1 Simple Merge Sort
 - *5.3.3.2 Polyphase Merge
- 5.4 Constant Coefficients
 - 5.4.1 The Characteristic Equation
 - 5.4.2 Undetermined Coefficients
 - *5.4.3 A Simple Queue
- 5.5 Divide and Conquer with Uneven Parts
 - 5.5.1 Medians
 - 7.4.3 Dynamic Programming
 - 7.4.3.1 Multiplying Series of Matrices
 - *7.4.3.2 Least-Cost Parsing

The last week or two of the course may cover additional topics as time permits. However, detailed questions that students might have on the above material has priority over any additional material.

Course grading.

The course grade will be determined primarily by the grade on the exams and the grade on the course project. The exams will count for 2/3rds of the grade and the project will count for 1/3rd of the grade. The course will have one or two midterms and one final. Each midterm counts for one unit and the final counts for two units. Thus, when there is one midterms, the midterm counts for 2/9ths of the grade, the midterm counts for 4/9ths, and the project counts for 3/9ths. When there are two midterms, each midterm counts for 2/12th, the final counts for 4/12ths, and the project counts for 4/12ths. In those rare cases where discussion and class room participation shows that the student understands the material better than the above formal indicates, an upward adjustment of 1/3rd of a grade may be made (based on the judgment of the professor).

The course also has graded homework but this grade is not counted towards the course grade. This homework is important, because most students who do not do it do poorly on the exams. The reason that the homework is not counted towards the grade is that each student is encouraged to get what ever help he or she needs to complete the homework assignments. One of the best ways to learn the material of the course is to do the assignments. Including the homework grade in the course grade would raise difficult questions as to what would be considered cheating on the homework. Since the homework grade does not count on the final grade, this problem does not arise. Rather the homework gives the student a chance to learn the material either alone or with help. The grading of the homework gives the student guidance on how well he or she has learned the material. The tests them informs the professor as to how well the student has learned the material.

The project and cheating.

The particular project and its grading is discussed in a separate document. The project is suppose to represent the student's own work. Be that as it may, the most important consideration if for the student to complete the project. This raises some delicate questions considering what is cheating and what is not. The simple rule is that the student should document all sources that contributed to the successful completion, including books, web sites, and people. So long as all significant sources are referenced there is no cheating. At the same time, if people made major contributions to the success of the project, some adjustment may be needed to the course grade.

It is understood that the student is likely to need help with secondary matters such as programming language details, how to time code, and such. In such cases, the student just needs to cite the various sources of help. On the other hand, help in writing the actual code, writing section of the report, and such is cheating if the help is not referenced, and when it is referenced by lead to some readjustment of the project grade.

If the student has questions about application of these rules, they should ask the professor (either in class or in his office, which ever they would prefer).