CSE 5311: ADVANCED ALGORITHMS

Summer 2003: MW 3:00-4:50, Nedderman Hall 229

Instructor:	Bob Weems, Associate Professor
Office:	344 Nedderman (weems@uta.edu, http://reptar.uta.edu)
Hours:	MW 12:30-2:30 pm
GTA:	Yongsheng Bai (yxb4544@omega.uta.edu)
Office:	412 Woolf Hall
Hours:	MW 1:00-3:00 pm
GTA:	Weimin He (wmhe@omega.uta.edu)
Office	201 Engineering Lab
Hours:	MW 8:00-10:00 pm

Prerequisites: Algorithms & Data Structures (CSE 2320)
Theoretical Computer Science (CSE 3315)

Objectives: Deeper study of algorithms, data structures, and complexity classes.

Goals:
1. Exposure to more sophisticated analysis techniques, e.g. amortized complexity.
2. Exposure to specialized data structures and algorithms.
3. Exposure to models of algorithm design.

Textbook: Cormen, Leiserson, Rivest, Stein, *Introduction to Algorithms*, *2nd ed.*, MIT Press, 2001. (Henceforth known as CLRS)

References:

S. Baase, *Computer Algorithms, Introduction to Design and Analysis*, *3rd ed.*, Addison-Wesley, 2000.

M.R. Garey and D.S. Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness*, Freeman, 1979.

G. Gonnet and R. Baeza-Yates, *Handbook of Algorithms and Data Structures, 2nd. ed.*, Addison-Wesley, 1991.

R.L. Graham, D.E. Knuth, and O. Patashnik, *Concrete Mathematics*, Addison-Wesley, 1989.

D. Gusfield, *Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology*, Cambridge University Press, 1997.

D. Gusfield and R. Irving, *The Stable Marriage Problem: Structure and Algorithms*, MIT Press, 1989.

D.S. Hochbaum, ed., *Approximation Algorithms for NP-Hard Problems*, PWS, 1997.

E. Horowitz and S. Sahni, *Fundamentals of Computer Algorithms*, Computer Science Press, 1978.

D.E. Knuth, *The Art of Computer Programming*, Vols. 1 and 3, Addison-Wesley.

R. Motwani and P. Raghavan, *Randomized Algorithms*, Cambridge Univ. Press, 1995.

C.H. Papadimitriou, *Computational Complexity*, Addison-Wesley, 1994.

R. Sedgewick, *Algorithms*, *2nd ed.*, Addison-Wesley, 1988.

T. Standish, *Data Structure Techniques*, Addison-Wesley, 1980.

C.J. Van Wyk, *Data Structures and C Programs*, Addison-Wesley, 1988.

N. Wirth, *Algorithms* + *Data Structures* = *Programs*, Prentice-Hall.

Exams: 2 exams, weighted equally.

Homework: Two assignments - NOT GRADED.

Grade: Your grade will be based on the following weights:

Exams:	80% (Test 2: August 11, 3:00-4:50 pm)
Labs:	20% (Four labs, equal weight)

Policies:

1. Attendance is not required, but is highly encouraged. Consult me in advance if you must miss class for a good reason.

2. You are expected to have at least skimmed the new material by the day we start that material in class. The material will be covered in the order given later.

3. A due date will be given for each homework. Solutions will be available from the web page before the due date. The GTA will assist with homework questions.

4. CHEATING - YOU ARE EXPECTED TO KNOW UNIVERSITY POLICIES. All cases of plagiarism will be processed through University channels outside the CSE department.

    a. **Academic Integrity Policy:** It is the policy of the University of Texas at Arlington to uphold and support standards of personal honesty and integrity for all students consistent with the goals of a community of scholars and students seeking knowledge and truth. Furthermore, it is the policy of the University to enforce these standards through fair and objective procedures governing instances of alleged dishonesty, cheating, and other academic/non-academic misconduct.

       You can assume responsibility in two ways. **First**, if you choose to take the risk associated with scholastic dishonesty and any other violation of the Code of Student Conduct and Discipline, you must assume responsibility for your behaviors and accept the consequences. In an academic community, the standards for integrity are high. **Second**, if you are aware of scholastic dishonesty and any other conduct violations on the part of others, you have the responsibility to report it to the professor or assistant dean of students/director of student judicial affairs. The decision to do so is another moral dilemma to be faced as you define who you are. Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the University. Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced.

b. **Statement on Ethics, Professionalism, and Conduct of Engineering Students**: The statement is attached. Continued failure to sign the statement will result in 1) late penalty on programming assignments and 2) failure on exams.

5. Any request for special consideration must be appropriately documented **in advance**. (Special consideration does not include giving a higher grade than has been earned.)

6. Late labs are penalized 30% per day. After the due date neither I, nor the GTA, will provide assistance.

7. Each student will have available *one* 48-hour no-penalty extension that may be applied to *one* of the lab assignments. To use your extension you must send an email to the grader *before* the due time.

8. Phone calls. I will not answer my phone during office hours if someone is in my office. After the third ring the call is switched to the CSE office, so please leave a message with the secretary.

9. Please email the following information to `yxb4544@omega.uta.edu` by Wednesday, June 4:

   a. Name (as listed by the university).
   b. Additional email addresses.
   c. Special circumstances affecting your performance.
   d. What books were used in your previous course(s) in algorithms and data structures?
   e. (Optional) What do you hope to gain from this course?

Course Outline

Starred (*) topics are not in CLRS

1. Mathematical Preliminaries
   - Recurrences - Master Method (4.3-4.4.1)
   - Probability and Randomized Algorithms (5)
2. Binary Search Trees
   - Rotations
   - Red-Black Trees - Review (13)
   - AVL Trees*
   - Augmenting Data Structures (14)
3. Amortized Analysis (17)
4. Self-Organizing Linear Search (Computing Surveys)*
5. Trees
   - Optimal Binary Search Trees (15.5)
   - Self-Adjusting Binary Search Trees (Splay trees/amortized analysis) (JACM)*
6. Skip Lists*
7. Priority Queues - Review (6.5)
   - Binary Trees, Binary Heaps, d-heaps, van Emde Boas PQ, Cartesian Trees, Leftist Heaps, Skew Heaps
   - Binomial Heaps (19)
   - Fibonacci Heaps (20)
8. Disjoint Sets (union-find trees) (21)
9. Hashing - Review, Brent's Rehash*, Perfect Hashing (11.5)
10. Medians/Selection (9.3)
11. Minimum Spanning Trees (23)
    - Brief review of Prim
    - Kruskal's Algorithm (application of union-find trees) and extension to detecting non-unique MST
    - Boruvka's Algorithm

TEST 1
12. Max-Flow/Bipartite Matching (26)
    Ford-Fulkerson - review, maximum capacity paths
    Push-relabel methods
    Vertex and edge connectivity
13. Depth-First Search (22.3)
    Strong Components (review)
    Biconnected Components
14. Stable Marriages*
15. Sequences
    Pattern-based
        Rabin-Karp Algorithm (32.2)
        Gusfield's Z Algorithm
        Knuth-Morris-Pratt Algorithm (32.4)
    Text-based - Suffix Trees and Suffix Arrays
    Longest Common Subsequences
        Dynamic Programming - Review and Linear Space Version
        Longest Increasing Subsequence Approach
16. Matrices
    Strassen's Matrix Multiplication (28.2)
17. Computational Geometry (33)
18. Intractability (34, 35)
    Sample Intractable Problems
    Complexity Classes
    Reductions
    Polynomial-Time Approximation

TEST 2

Calendar/Topics

	May/June				July/August		
26	Holiday	28	Syllabus/1.			2	12.
2	1.	4	2.	7	Exam 1	9	12.
9	3.	11	4.	14	12./13.	16	13.
16	5./6.	18	7.	21	14./15.	23	15.
23	8.	25	9./10.	28	16./17.	30	18.
30	11.			4	18.	6	18.
				11	Exam 2		

July 25 is the last day to withdraw.