FINAL EXAM STUDY SHEET, CS 3137, Spring 2014

The final is on Tues., May 13, 9 - 12 in 833 Mudd. It will be closed book and notes, and will be similar to the midterm in style, although longer. The final is 3 hours long, but you should have plenty of time to complete it.

HERE ARE A FEW SAMPLE PROBLEMS FROM THE 2ND HALF OF THE CLASS. KEEP IN MIND YOU ARE RESPONSIBLE FOR MATERIAL FROM THE ENTIRE SEMESTER. Anything we covered in the book and in class or recitation is fair game. The topics below are NOT an exhaustive list of what will be on the final! You should also go over the midterm study sheet (posted on web in class notes section).

1 Given the adjacency matrix for a **directed** graph below do the following:

a) Draw the graph.

b) Compute the transitive closure matrix of this graph.

c) Using the matrix in part b), how would you determine if the graph had a cycle?

	A	B	C	D	E
A	0	1	1	0	0
B	0	0	1	0	0
C	0	0	0	1	0
D	0	1	0	0	0
E	0	1	0	0	0

2. DEREG AIRLINES uses the table below to find out what flights to take to get from one city to another.

DEREG AIRLINES FLIGHT CONNECTIONS TABLE					
	to city 1	to city 2	to city 3	to city 4	to city 5
from city 1	-	-	305	278	-
from city 2	101	-	234	176	-
from city 3	076	005	-	-	-
from city 4	432	901	675	-	765
from city 5	-	211	303	180	-

The table says that there is no direct service from city 1 to cities 2 and 5, direct service from city 1 to city 3 on flight 305, direct service from city 1 to city 4 on flight 278 and so on. Travel between two cities can also be indirect. For example, to go from city 1 to city 5 we can take flight 278 to city 4 and then flight 765 to city 5. You have been hired by DEREG to help create a program that takes as input two city numbers and prints out what flight or series of flights link the two cities.

a) (3 points) Describe a JAVA data structure you would use to store the table above (you can assume the number of cities served by DEREG is always 5).

b) (6 points) Write a *recursive* method in JAVA

findroute(int from, int to, int flight[ ], int flightarray_index)

that will return in the array **flight** the flight number or numbers (if intermediate flights are needed) that link two cities or an empty array if there is no path between them. Assume the data structure you built in part a) above is global to your method.

c) (3 points) Discuss (DO NOT WRITE CODE) how you might modify or change your data structure in part a) to allow for more than one flight being scheduled between two cities. (Don’t worry about how this change affects part b).

3 Since you are now an expert on Data Structures, you have been asked by Virgin records to help them keep track of their extensive and growing list of CDs, cassettes, DVD’s and videotapes. Virgin needs to create a computerized data base that will automatically do the following:

i) Given an artist’s name, a list of all CD’s, cassettes, DVD’s and videos by that artist will be printed, in chronological order. The list can be printed out for just CD’s by the artist, just cassettes, just DVD’s, just videotapes or all together.

ii) Given a title of a CD, cassette, DVD or movie, the associated artist’s name will be printed.

Since Virgin has thousands of titles, the method you implement must be efficient in being able to extract the information quickly, with a minimum of search. In addition, it must be stored compactly, without duplicating lots of data. Keep in mind that this data changes frequently - new titles are being added and old titles deleted constantly.

a) Describe how you would set up the appropriate data structures to solve i and ii above.

b) Describe the search methods you would use to for i and ii above

c) Justify why the search methods and data organization you chose are efficient and don’t waste space.
NOTE: DO NOT WRITE ANY CODE FOR THIS PROBLEM!!

4. Given a directed graph represented by the adjacency list in figure 3:

Adjacency List				
Node	Pointers			
1	2	3	5	nil
2	3	4	nil	
3	2	4	nil	
4	nil			
5	2	3	4	nil

Figure 3.

a) Draw the graph.

b) List the nodes in the order they would be visited using depth first search with the adj. list.

c) List the nodes in the order they would be visited using breadth first search with the adj. list.

d) Describe in English the steps involved in a topological sort of a directed graph.

5 Below is a table of mileage distances between 7 cities. Suppose you want to build a pipeline that links all these cities using the minimum amount of pipe. List the city-pairs that would be linked in building this pipeline.

City	Denver	Salt Lake	Albuquerque	Oklahoma City	Cheyenne	Omaha
Salt Lake	512					
Albuquerque	422	611				
Oklahoma City	615	1108	525			
Cheynne	102	462	522	706		
Omaha	540	955	895	454	493	
Dodge City	301	682	425	212	355	336

6 Show the Huffman coding tree that would result from encoding the characters:
AABBBCDEEEEFFFF

7 Suppose you have an array of N elements to sort, and that these N elements only have 2 distinct keys, 0 or 1. Describe in English or pseudo-code an O(N) algorithm to sort the elements so that all 0 key records precede all 1 key records. You may use a few temporary variables but you may not use another array in your solution.

8 Prove by induction that the number of arcs in a complete undirected graph of N nodes is N*(N-1)/2.

9 Solve the recurrence equation T(N) = N + 2 T(N/2) if T(1)=1. Name an algorithm we studied that fits this model.

10 What is the computational complexity of Kruskal’s algorithm? Topological sorting? Dijkstra’s algorithm?

11 Given min-heap of N items stored in an array A[1-N], describe an algorithm to turn this into a max-heap. What is the complexity of your method?

12 Insert the following into an array, then write Java code to build it into a heap, illustrating each step both in the array diagram and in tree diagram: 6 5 4 3 1 2. Then show how to do a DeleteMin, making sure you restore the heap property.

13 Add the numbers 13,16,24,12,17,5 to a Hash table of Bucket Size 7 using the hash function of NUM%BUCKETSIZE. Show the table if an open adressing scheme with linear probing is chosen for the hash table.