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## BITS WILP Data Structures and Algorithms Design End-Sem Exam (Regular) 2016-H2

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Birla Institute of Technology & Science, Pilani  
Work-Integrated Learning Programmes Division  
First Semester 2016-2017  
EC-3 Regular Comprehensive Examination  
Course Title : Data Structures and Algorithms  
Course No : SS ZG 519  
Total : 50 marks  
Nature of Exam : Open Book  
Duration : 3 hours  
Date : 05/11/2016 (AN)  
No. of Pages = 2  
No. of Questions = 5  
Note:

1. Please follow all the Instructions to Candidates given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.
1. (a) Write a program to list out all the monotonic increasing subsequence of an array of integers. For example, for the input is 1; 4; 2; 7; 9, output will be 1; 1; 4; 1; 2; 1; 7; 1; 4; 7; 1; 2; 7;
- 1; 9; 1; 4; 9; 1; 2; 9; 11; 7; 9; 1; 4; 7; 9; 1; 2; 7; 9; 4; 4; 7; 4; 9; 4; 7; 9; 2; 2; 7; 2; 9; 2; 7; 9; 7; 7; 9; 9;
- (4Marks)
- (b) What is the running time of your program and justify your answer. (3Marks)
- (c) Prove that  $af(n) + bg(n)$  is  $O(\max\{f(n); g(n)\})$  where  $a$  and  $b$  are some constants.
- (3Marks)

2. The goal of n-queens problem is to place n queens on a  $n \times n$  chessboard such that no queen attacks any other queen (A queen attacks any queen if it is in the same row, or column or diagonal). Following is a figure shows an attempted solution that fails (two queens on the same diagonal) for 8-queens problem.

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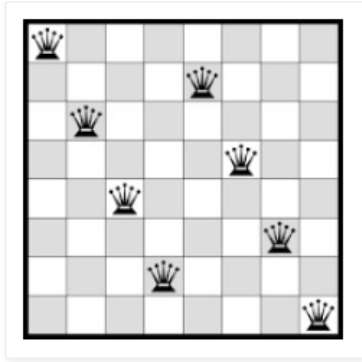
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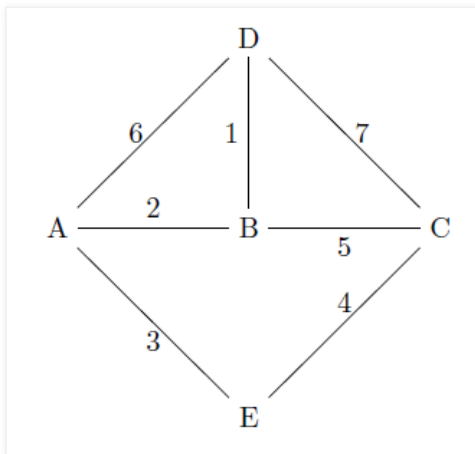
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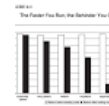


- (a) Formulate the problem so that we can use a greedy algorithm: That is, describe the states, initial state, successor states for each state. Which data structure will you use to represent the state? (4Marks)
- (b) Write an algorithm to generate all successor states of a given state? (3Marks)
- (c) Write an algorithm to check whether no queens attack each other in a given state. (3Marks)
- (d) Provide a strategy to pick up the best state from the set of successor states of a given state and justify why you think it is a best strategy. (2Marks)
3. Draw the hash table of size 11 resulting from hashing the keys 45, 93, 97, 58, 53, 105, 26, 41, 31.
- (a) Using the hash function  $h(i) = (i - 5) \bmod 11$  and assuming collisions are handled by chaining. (3Marks)
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- (b) Using the same hash function but collisions are handled by linear probing. (2Marks)
- (c) Using the same hash function but collisions are handled by quadratic probing. (2Marks)
- (d) Using the same hash function but collisions are handled by double hashing with secondary hash function  $h'(k)$  where  $h'(k)$  is denoted as the least significant digit in  $k$ . For example  $h'(45) = 5$ . (2Marks)
4. (a) Provide a best case instance for the heap sort algorithm. We are not assuming anything about the input and the best case running time is  $O(n)$ . (5Marks)
- (b) Modify insertion sort so that the output will be in decreasing order. (2Marks)
- (c) We used decision trees to model comparison based algorithms for instances of size  $n$ . Draw a decision tree for your algorithm for the input size 4. (4Marks)
5. (a) Construct the adjacency matrix and adjacency list for the following graph.



- (4Marks)
- (b) Construct a simple, connected, weighted graph with 7 vertices and 12 edges and each with unique edge weights. Identify one vertex as a start vertex and illustrate a running on Dijkstra's algorithm on this graph. (4Marks)

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