

MANIPAL UNIVERSITY

FIRST SEMESTER VLSI-CAD / MEDICAL SOFTWARE / EMBEDDED SYSTEMS
DEGREE EXAMINATION – DECEMBER 2008-JANUARY 2009

SUBJECT: DATA STRUCTURES & ALGORITHMS (EDA 103 / MS 103 / ES 101)

QUESTION BANK

1. Write a function to delete an element at any position in doubly linked list. 10
2. What is a stack? What are the applications of stack? Implement stack using linked list. 10
3. Write a function to insert an element at any position to doubly linked list. 10
4. What is a queue? Describe the pointer implementation of queues. Write the functions enqueue and dequeue associated with this implementation. 10
5. What is a circular queue? Write the functions insert-queue and delete-queue associated with this implementation. 10
6. a) What are stacks 2
b) Write the algorithm of PUSH and POP operations on the stack 6
c) List any two applications of stack 2
7. a) What are queues? Describe the array implementation of queue with necessary functions. 2+6
b) List any two application of queue. 2
8. a) Distinguish between normal queue and circular queue. 2
b) Write the functions for Insert and Delete operations on circular queue. 8
9. a) Write function to add an item into a singly linked list and display the list 4+2
b) Write function to search an element from a singly linked list. 4
10. a) Write function to delete an item from a doubly linked list. 5
b) Write function to display the content of doubly linked list from head to tail and tail to head 2.5+2.5

11. Write a function to find a factorial of a number and derive the time complexity. 10
12. What is an algorithm? Explain different criteria, an algorithm should satisfy. 10
13. How do you analyze the performance of an algorithm? 10
14. Write a function to multiply 2 matrices. Show that it's time complexity is $O(n*n*n)$. 10
15. Explain 'Big oh' notation, Omega notation and Theta notation. 10
16. Explain a) Data Structure b) Algorithm c) Performance of Algorithm . 10
17. Solve the following recurrences with $T(1)=1$ 5+5
 - a) $T(n)=4*T(n/3)+n$
 - b) $T(n)=9*T(n/3)+n^2$
18. Solve the following recurrences with $T(1) = 1$ 5+5
 - a) $T(n) = 2*T(n/2) + n$
 - b) $T(n) = T(2*n/3) + O(1)$
19. Write short notes on Space complexity and Time Complexity. 10
20. With example explain how you are determining Space complexity and Time complexity of an algorithm. 10
21. Write the code for creating Binary Tree using pointers. Write a recursive function for in-order traversal of a binary tree. 10
22. Write a non recursive in-order traversal of a binary tree. 10
23. What are the properties of Binary Search Tree? Write a recursive function for implementation of binary search tree. 10
24. Write the code for creating Binary Tree using pointers. Write a recursive function for Pre-order traversal of a binary tree with suitable example 10
25. Write an algorithm for deleting an item from binary search tree. Give example for different cases. 10
26. Write function for creating the following 5+5
 - a) Binary Tree
 - b) Binary search Tree
27. Write a function for level order traversal of a binary tree. Illustrate with an example. 10
28. a) Write a recursive function for creating binary search tree. 5+5
 - b) Write a recursive function for search an element in a binary search tree.
29. Write functions for a) In-order b) Pre-order c) Post-order traversals and print output for each traversal. 10

30. a) Write a recursive function for finding the height of a binary tree. 5+5
 b) Write recursive functions for in-order and post-order traversal for binary tree.
 Illustrate with example.
31. Write a function for Merge Sort. Derive its time complexity. 10
32. Write a function for sorting N numbers using Insertion Sort technique. Illustrate the working with an example. 10
33. Write function for sorting N numbers using Heap Sort. Derive its time complexity. 10
34. Write a function for sorting 'n' numbers using quick-sort. Illustrate the working with an example. Derive its worst case time complexity. 10
35. Write a function for sorting N numbers using Bubble Sort and Selection sort techniques. Derive the time complexity. 10
36. Write an algorithm to sort N integers using bubble sort technique. Analyze its time complexity. 10
37. Write an algorithm to sort N integers using selection sort technique. Analyze its time complexity. 10
38. Write functions for the following
 a) Insertion sort b) Selection sort 5+5
39. Write functions for the following
 a) Bubble Sort b) Insertion Sort 5+5
40. Write functions for the following and give worst case time 5+5
 a) Extracting Maximum element from Heap
 b) Inserting element into Heap
41. Giving an example write the function for building adjacency list of a Graph. 10
42. Write a function for Breadth First Search traversal of a Graph. 10
43. Define minimum spanning tree. Describe Prim's algorithms for finding the minimum spanning tree and illustrate with an example. 10
44. Write code for the SINGLE SOURCE SHORTEST PATHS problem. Illustrate this with an example. 10
45. Define minimum spanning tree. Describe Kruskal's algorithms for finding the minimum spanning tree and illustrate with an example. 10
46. Write short notes on the following (with respect to graph). 2.5 x 4

- a) Spanning Tree b) Connected Graph
c) Simple path d) Complete Graph
- b) Prove that the number of edges in an n -vertex complete graph is $n(n-1)/2$. 5+5
47. Write short notes on following with respect to graph 2 x 5
b) Walk b) Path c) Incidence d) Degree e) Cycle
48. Write short notes on the following (with respect to graph) 2.5 x 4
a) complete graph b) connected & disconnected graph
c) directed & undirected graph d) Component
49. Describe Prim's and Kruskal's algorithms for finding the minimum spanning tree. 10
50. Write short notes on the following (with respect to graph) 2.5 x 4
a) complete graph b) connected graph
c) degree of graph d) Cycle
51. Give a divide-and-conquer method for multiplying two long integers. Derive its time complexity. 10
52. Describe the Strassen's matrix multiplication method for multiplying two matrices. Derive its time complexity. 10
53. Discuss the following with respect to divide and conquer technique 5+5
a) Strassen's Matrix Multiplication
b) Multiplication of long integers
54. Write divide and conquer algorithms for 5+5
a) Finding the maximum & minimum of ' n ' numbers.
b) Searching element using binary search technique. Discuss time complexity.
55. Discuss the following with respect to divide and conquer technique 5+5
a) Multiplication of long Integers.
b) Finding the maximum & minimum of ' n ' numbers.
56. Discuss the difference between Divide and Conquer Technique with Dynamic Programming. 10
57. Write short notes on 5+5
a) Closest pair of points. b) Finding the maximum & minimum of ' n ' numbers.
58. Write a divide-and-conquer algorithm to find the maximum and minimum of ' n ' numbers. Show that it takes lesser time than the standard method. 10
59. Write a recursive function for binary search. What is its time complexity? 10

60. Give a divide and conquer solution for finding the closest-pair of points among 'n' points.

10

61. Write a dynamic programming algorithm for matrix chain multiplication. What is its time complexity?

10

62. The product $A_1 * A_2 * A_3$ of 3 matrices is to be obtained. Their dimensions are given below

A_1 10x100

A_2 100x5

A_3 5x50

Obtain the proper order of multiplication of the matrices so that the total number of scalar products is a minimum. Use a dynamic programming algorithm for solving the above matrix chain multiplication problem.

10

63. Write a dynamic programming algorithm for finding an Optimal Binary Search tree.

Illustrate with an example.

10

64. *Let $n = 4$ and $(a_1, a_2, a_3, a_4) = (\text{do}, \text{if}, \text{int}, \text{while})$. Let $p(1:4) = (3, 3, 1, 1)$ and $q(0:4) = (2, 3, 1, 1, 1)$ (The p 's and q 's have been multiplied by 16 for convenience). Obtain the optimal binary search for the above identifiers using dynamic programming algorithm.

10

65. Write a dynamic programming algorithm for the ALL PAIRS SHORTEST PATHS problem. Illustrate this with an example.

10

66. Explain the various steps of Dynamic Programming algorithm with an example.

10

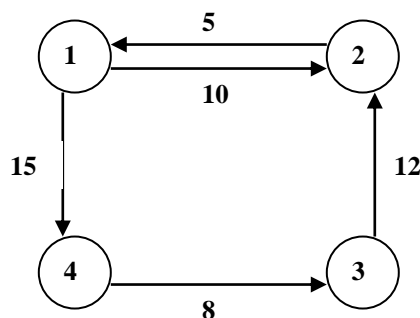
67. *Write a dynamic program for knapsack problem.

10

68. Write the algorithms for All pairs shortest paths using Dynamic Programming technique.

Derive All pairs shortest paths for the following example

5+5



69. Write the algorithms for the following with respect to dynamic programming 5+5
 a) *Optimal Binary search Tree. b) All pairs shortest paths.
70. Write the algorithms for the following with respect to dynamic programming 5+5
 a) Matrix chain Multiplication. b) *Optimal Binary Search Tree.
71. Let $w = \{ 5, 7, 10, 12, 15, 18, 20 \}$ and $m = 35$. Find all possible subsets of w that sum to m .
 Do this using SumOfSub. Draw the portion of the state space tree is generated. 10
72. Let $w = \{ 5, 10, 12, 13, 15, 18 \}$ and $m = 30$. Find all possible subsets of w that sum to m . Do
 this using SumOfSub. Draw the portion of the state space tree is generated. 10
73. Discuss the following problems with respect to Back tracking Technique 5+5
 a) N Queen Problem. b) Sum of Subsets Problem.
74. Write a backtracking algorithm to find all solutions to the n queen's problem. 10
75. Describe a recursive backtracking algorithm for the sum of subsets problem. 10
76. Write the algorithms for the following with respect to Back tracking Techniques. 5+5
 a) N Queen Problem. b) Sum of Subsets Problem.
77. Write the algorithms for the following with respect to Back tracking Technique 5+5
 a) Graph Coloring Problem. b) N Queen Problem.
78. Write a backtracking algorithm for finding all m -colorings of a graph. 10
79. Discuss Backtracking design technique. Explain and write algorithm for N Queen
 problem. 10
80. Write the algorithms for the following with respect to Back tracking Technique 5+5
 a) Sum of Subsets Problem. b) Graph coloring Problem.
- ~~81. Distinguish between linear and binary search technique. Discuss the time complexity. 10~~
- ~~82. Compare time complexities of Bubble sort, insertion sort, heap sort, merge sort and quick
 sort. 10~~
- ~~83. Distinguish between normal queue and priority queue. What are the applications of
 heaps? 10~~
84. What is hashing? Briefly explain various Hashing techniques. 10
85. Explain Closed hashing technique (using arrays) with required functions. 10
86. Explain separate chain hashing (using linked list) technique with required functions. 10
87. What do you mean by collision in hashing? Write short notes on various collision
 resolution techniques. 10

88. Write short notes on 5+5
- a) Separate chain Hashing (linked list) b) Closed Hashing (array)
89. Why hashing technique is required? Explain different hashing techniques. 10
90. Explain with example various collision resolution techniques used in closed hashing (Array based). 10
91. With respect to Greedy approach write the following algorithms with examples 5+5
- a) Knapsack problem. b) Job sequencing with deadlines.
92. With respect to Greedy approach write the following algorithms with examples 5+5
- a) Optimal storage on Tapes. b) Job sequencing with deadlines.
93. Solve the following problems using greedy method 5+5
- a) Let $n = 4$, $(p_1, p_2, p_3, p_4) = (100, 10, 15, 27)$ and $(d_1, d_2, d_3, d_4) = (2, 1, 2, 1)$. Generate the list of feasible solutions, processing sequence and profit earned. Give the Optimal solution.
- b) Consider an instance of knapsack problem: $n = 3$, $m = 20$, $(p_1, p_2, p_3) = (25, 24, 15)$, and $(w_1, w_2, w_3) = (18, 15, 10)$. Generate at least 3 feasible solutions which includes an optimal solution.
94. Solve the following problems using greedy method 5+5
- a) Let $n = 4$, $(p_1, p_2, p_3, p_4) = (100, 10, 15, 27)$ and $(d_1, d_2, d_3, d_4) = (2, 1, 2, 1)$. Generate the list of feasible solutions, processing sequence and profit earned. Give the Optimal solution.
- b) Consider three programs with lengths $(L_1, L_2, L_3) = (5, 10, 3)$. Generate all possible ways of storing the programs with corresponding MRT. Give the optimal ordering of storing programs.
95. Solve the following problems using greedy method 5+5
- a) Consider three programs with lengths $(L_1, L_2, L_3) = (5, 10, 3)$. Generate all possible ways of storing the programs with corresponding MRT. Give the optimal ordering of storing programs.
- b) Consider an instance of knapsack problem: $n = 3$, $m = 20$, $(p_1, p_2, p_3) = (25, 24, 15)$, and $(w_1, w_2, w_3) = (18, 15, 10)$. Generate at least 3 feasible solutions which includes an optimal solution.

96. Write short note on Priority queue. Write functions for Inserting and deleting elements from priority queue (Use Heaps). 10
97. Implement a priority queue with both insert and delete-minimum running in $O(\log n)$ time. 10
98. Describe a $O(n \log n)$ time algorithm that, given a set of n real numbers and another number x determines whether or not there exists two elements in the set whose sum is exactly x . 10
99. Consider a modification to merge sort in which ' n/k ' sublists of length ' k ' are sorted using insertion sort and then merged using the standard merging mechanism. 3+7
- a) Show that ' n/k ' sublists each of length ' k ' can be sorted by insertion sort in $O(nk)$ worst-case time.
 - b) Show that sublists can be merged in $O(n \log n/k)$ worst-case time.
100. Explain the different ways of implementing priority queue. Discuss the time complexity of each implementation. 10