National Institute of Technology Suratkal
Information Technology Department
IT 200 Data Structure & Algorithm

Class Test 1: 20 Marks: 45 Minutes

1. Find the general solution for the given reccurrence relation
   T(n) = 4T(n-1) – 5T(n-2) – 2T(n-3) **4Marks**

2. Sol the following recurrence relations **2Marks**
   (i) T(n) = 4T(n/2) + cn
   (ii)T(n) = 16T(n/2) + c(n^4)

3. Write itn series on instruction to delete a node pointed by an temperary pointer T.
   3Marks pseudo (doubly)

4. Consider an order link list which allows duplicate enteries asn now write the deleteAll function that delete all the nodes with given value x. Func **4Marks**

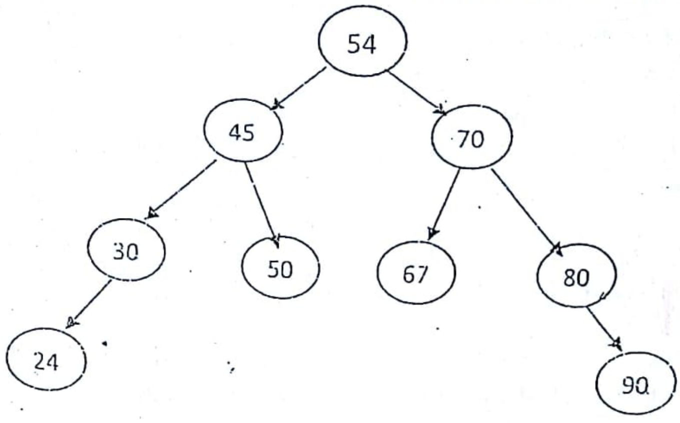
5. Consider we want to implemant K number of stack on one array of size N (Assume N = K*m) now write the initial condition and condition for stack to full. **5Marks**

National Institute of Technology Karnataka (Surathkal)

IT 200 Data Structure and Algorithms Class Test 2

Max Marks 15 Time : 45 Minute

1. Consider the following AVL tree, Write balance factor of all the node of the given AVL Tree



2 Marks

2. Insert 95, and then 75 in the above AVL tree 2+3 Marks

3. Write the recurrence relation of the quick sort for the worst case where we choose pivot element such that at-least one-third element is greater than pivot element and at-least one-third element is ~~greater~~ lesser than pivot element. 3Marks

4. Let we have a huge array of size 'n' in which a few 'k' (k<<<n) element are ~~not its proper~~ not in its proper position(All other are in there proper position) choose the sorting which is best suitable for above case. 2Marks

5. Compare "Selection sort", "Insertion Sort", and "Bubble Sort" in terms of data movement operation for the worst case (consider swap requires 3 data movement operation) 3Marks

1. Given a singly linked list L, formulate separate algorithms to

   I. Insert an element X after position P in the list. 2

   II. Delete the first occurrence of an element Y from the list. 3

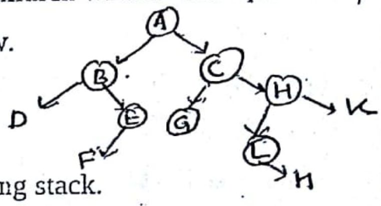
   Trace the algorithms with suitable examples.

2. Explain the case in BST where node to be deleted has 2 children with an example. 1

3. Construct a binary tree for the traversal order given below. 3

   Preorder: A B D E F C G H L J K

   Inorder: D B F E A G C L J H K



4. Convert the following expression from infix to postfix using stack. 2

   (a+b^c^d)*(e+f/d) → abc^d^+e*fd\+

5. Evaluate the postfix expression given below. 1

   6 2 3 + - 3 8 2 / + * 7.

6. Explain quadratic probing. Insert element into hash table using quadratic probing. 3

   76, 40, 48, 5, 55 (Explain each step of insertion). Hash table size = 7

7. Write an algorithm for tower of hanoi problem and explain it with an example. 2

8. Explain big θ and big Ω notations with suitable examples. 2

   ·Ω lower bound of unsorted array

   ↑ (tight) ↑ Average ~~best~~ Lower lower

(a+b^c^d)*(e+f/d)

ch	stack	Output
(	(	a
a		
~~*~~ +	(+	ab
b		
^	(+^	abc
c		abc^
^	(+^	abc^d
d	(+^)	abc^d^+
)		
*	*	abc^d^+e
e +	+	abc^d^+e*Fd~~*~~/+
	/	

·6 2 3 + - 3 8 2 / + *

~~6~~ 5 - 3 8 2 / + *

1 3 8 2 /

1 3 4 +

1 7 * ⇒ 7

→ check

abc^d

~~ab^c^d~~

a+(b^c^d)*e+f/d

Page 1 of 2

9. Find big O notation and worst case running time of the following algorithm. 3

```
Procedure mystry(n: integer);
var i,j,k:integer   } O(1)
begin
        for i:=1 to n-1 do
O(n³)   for j:=i+1 to n do
        for k:=1 to j do
        { Some statement requiring O(1) time}
        end
```

$O(n^3) + O(1)$

$\approx O(n^3)$.

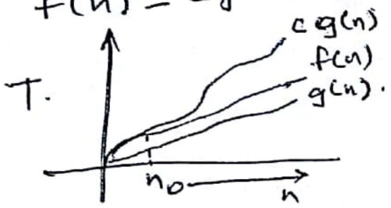
n^3

10. Explain Circular Queue. Formulate algorithms to 3

I. Enqueue in circular queue

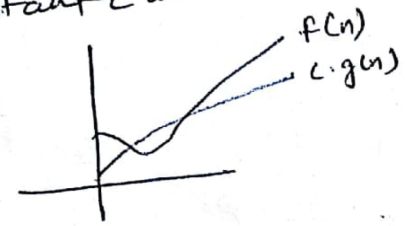
II. Dequeue in circular queue

A function f(n) ~~is so~~ (where n is size of input) is said to be $O(g(n))$ ie $f(n) = O(g(n))$ if there exist a constant c and n_0 such that $f(n) \le c g(n)$ for all $n \ge n_0$.



This is used for Worst Case.
Eg: sorting of Array in descending order when all are in ascendes.

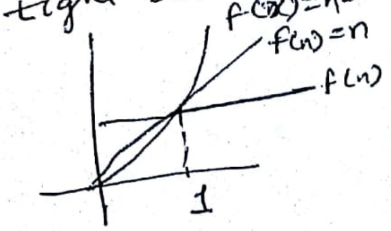
A function f(n) is said to be $\Omega(g(n))$ ie $f(n) = \Omega g(n)$ if there exist a constant c and n_0 such that $f(n) \ge c g(n)$.



This used for best case
Ex → sorting of unsorted array in ascending when all the already sorted.

A function f(n) is said to be $\Theta g(n)$ ie $f(n) = \Theta g(n)$ if there ex[ist] ~~a~~ constants c_1, c_2 and n_0 such that $c_1 g(n) \le f(n) \le c_2 g(n)$. This tight bond used for average case.

-----XXXXX-----



~~$n^2 - n \ge 0$~~

~~$n(n-1) \ge 0$~~

~~for $n_0 = 1$~~

Reg No. | | | | | |

15CO228

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING, NITK
MID – SEMESTER EXAMINATION SEPT 2016

III SEM B.TECH (CSE) - CO203- DATA STRUCTURES AND ALGORITHMS

Max. Marks: 40
Time: 90 minutes

1. (a) Explain an efficient way of storing two symmetric matrices of the same order in memory. (5 marks)

   (b) Discuss the implementation of circular queue with array. (5 marks)

2. (a) An arithmetic expression is given in infix form (parenthesized). Write an algorithm to check whether the parentheses are correctly balanced or not. (5 marks)

   (b) Write an algorithm to evaluate a given postfix expression. (5 marks)

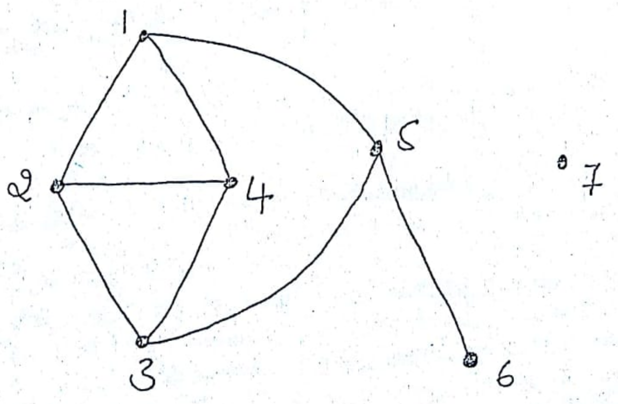
3. Discuss how sparse matrix can be represented with linked list. (6 marks)

4. Let us say that a tree is binary if every internal node has two children. This means that the root has degree 2 and every other internal node has degree 3. Prove that a binary tree on "k" leaves has "k-1" internal nodes. (6 marks)

5. Can there exist a simple graph with exactly one vertex of odd degree and all other vertices having even degree ? If YES, construct such a graph or if NO, give a reason why it is not possible. (2 marks)

6. Give the Adjacency Matrix and Adjacency List representation of the following graph. What is space requirement in each of the representation in terms of "n" and "m", where "n" and "m" denote respectively the number of vertices and the number of edges in the graph. (6 marks)

$V(G) = \{1, 2, 3, 4, 5, 6, 7\}$



Buble sort
Selection sort } Algo.

Class: III SEM B.TECH (IT)
Date: 09/09/2014

Time: 1½ Hrs.
Marks: 30

NOTE: 1. Answer all questions
2. Answer to the point

Register No.

1	3	1	T	1	1	1

1. Prof. Richard Feynman's algorithm to solve a problem is as follows (Courtesy Murray Gell-Mann) **(1+1=2 marks)**
   1. Write the problem on a piece of paper.
   2. Think really hard about the problem.
   3. Write the answer.

   Is this technically an algorithm? If yes then give reasons, if not, why not?

2. A machine has instructions which contains opcode representing basic operations like add, sub, mul etc **(1+1=2 marks)**
   1. Suggest a data structure to store operands.
   2. Substantiate your claim.

3. Assume that you have dropped out of B.Tech and have become a real estate agent in search of quick and easy money. In future it so happens that money earned is proportional to the number of plots. Being well-versed in IT200 choose an algorithm discussed in class which maximizes the profit, however impractical it might be to use it in the real world. **(1 mark)**

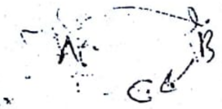
4. Let $S=\{0,1,\ldots,n-1,n\}$ be a set, $|S|=n+1$. Given a singly linked list containing 'n' elements of the set S in no particular order, design an $O(n)$ algorithm to find the missing element. (Hint: there are two ways of doing it, one is language dependent, the language independent algorithm gets full marks) **(5 marks)**

5. Prove that $\begin{pmatrix} F_{n+1} & F_n \\ F_n & F_{n-1} \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix}^n$ using mathematical induction. Where F_n is the 'n'th Fibonacci number. **(5 marks)**

6. Given a pointer to a node in a singly linked list, give an algorithm to remove it. **(5 marks)**

7. Standard algorithm for matrix multiplication results in the following recurrence. $T(n)=8T(n/2)+\Theta(n)^2$. Solve $T(n)=8T(n/2)+n^2; T(1)=1$. **(5 marks)**

8. If we add an additional constraint to the tower of hanoi problem that a disk cannot move directly from one peg to the other (i.e. all movements should be of the form A->B->C,B->C->A,C->B->A). Then how many moves does it take for 'n' disks. A proof should be provided. (Hint: it is not 2^n-1) **(5 marks)**



$3^n - 1$

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

END SEMESTER EXAMINATION, NOVEMBER 2014

IT200: DATA STRUCTURES AND ALGORITHMS

Class: III SEM B.TECH (IT)
Date: 26/11/2014

Time: 3 Hrs.
Marks: 100

NOTE: 1. Answer all questions
2. Answer to the point

Register No. 13IT151

---

1. Answer the following: **(7 + 1 + 2 + 3 + 7 = 20 marks)**
   1. Solve the recurrence $T(n)=T(n-1)+n^2, T(1)=1$ using repeated expansion.
   2. Let $A[1...n]$ be an array of distinct numbers, if $i<j$ and $A[i]>A[j]$ then $\langle i,j\rangle$ is called an inversion of A
      1. For the array $\{2,3,8,6,4\}$, list all the inversions.
      2. What array with elements from the set $\{1,2,3,...,n\}$ has the most inversions?
      3. What is the relationship between the running time of insertion sort and the number of inversions in the input array? Justify your answer
      4. Give an efficient algorithm to count the number of inversions in an array.

2. Answer the following: **(12 + 8 = 20 marks)**
   1. Let $S=\{0,1,2,...,n\}$ be a set.. Given a singly linked list containing $n-1$ elements of the set in no particular order, design an $O(n)$ algorithm to find the missing elements. Can the algorithm be generalized so that it would find k missing elements of the list which contains $n-k+1$ elements of the given set?
   2. Describe the *HEAP−SORT* algorithm with an example. The description should also contain the *MAX−HEAPIFY* and *BUILD−HEAP* routines.

3. Answer the following: **(10 + 5 + 5 = 20 marks)**
   1. Build an AVL tree using the input $\{5,2,3,1,4,9,6,7,8,10\}$. Draw the tree for every insert operation and show the rotations clearly.
   2. Given the frequency series for a Huffman code as follows:
      $$f_i=\begin{cases}4, i=1\\ 2^i, i\geq 2\end{cases}$$
      Draw the structure of the Huffman Tree that describes this series.
   3. Professor Dolores Umbridge thinks that she has discovered a new property of binary search trees. Suppose that the search for key k in a binary search tree ends up in a leaf. Consider three sets: A -> the keys to the left of the search path; B -> the keys on the search path; and C -> the keys to the right of the search path. Now the professor claims that any three keys $a\in A, b\in B, c\in C$ must satisfy the property $a\leq b\leq c$. Give a counter example to prove her wrong.

0, 1, 2, 4, 6

$\underbrace{0, 1, 2, 3, 4, 5, 6}_{0 \qquad n}$

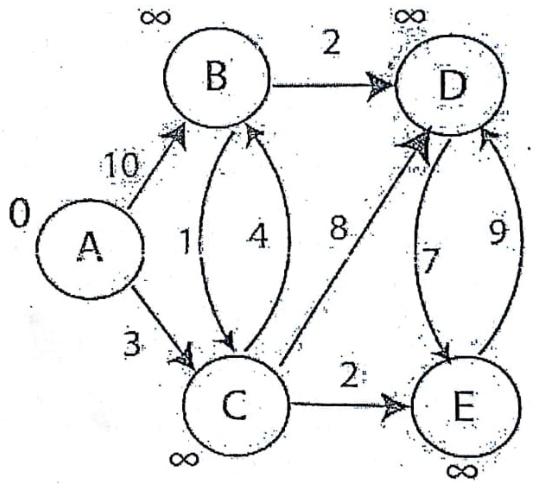
4. Answer the following: **(10 + 10 = 20 marks)**

1. Prove that the height h is given by the expression $h \approx 1.44 * \lg n$ for the sparsest AVL tree of n nodes.

2. Using binary search which works in $O(\lg n)$ time, describe an $O(n \lg n)$ time algorithm that, given a set S of n integers and another integer x, determines whether or not there exist two elements in S whose sum is exactly x where S can be either sorted or unsorted.

5. Answer the following: **(5 + 2 + 2 + 2 + 9 = 20 marks)**

1. Run Dijkstra's algorithm on the following graph and find the shortest paths choosing A as your source vertex. Write all the intermediate steps.



2. Your club is hosting a party consisting n people. A celebrity in any party is defined as follows. If c is a celebrity then everyone in the party knows c and c doesn't know anyone in the party. Being an expert in IT200, you have been hired to find the celebrity. You can ask n questions in total.
   1. Which data structure do you use to represent this problem? Why is it efficient?
   2. Can there be more than one celebrity in a party? How/why?
   3. Can there be zero celebrities in a party? How/why?
   4. Describe an $O(n)$ algorithm to find the celebrity.

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

MID SEMESTER EXAMINATION, SEPTEMBER 2015

IT200: Data Structure and Algorithms

Class: III SEM B.TECH (IT)
Date: 08/09/2015

Time: 1½ Hrs.
Max. Marks: 50

Register No. 14IT230

NOTE: 1. Answer All Questions To The Point

1. Solve the following recurrence relation
   1.1. T(n) = 3T(n-1) + 1 — 4M
   1.2. T(n) = 4T(n/4) + c*n — 4M

2. Write an algorithm to delete all the nodes in the singly link list whose location is in multiple of "k" where "k" is pass as an argument to the given delete function. — 8M

3. Write the PUSH and POP operation for a stack "i" (for all i<k) where we implementing k different stack in a single array of size N(consider N= k*m) — 8M

4. Consider an application where we want to implement a service program such that service is provided on the first come first serve basis and maximum 10 people are allowed to wait for the service. Suggest best data structure for given scenario with its implementation. — 8M

queue

5. Consider if we insert the 'n' elements in a BST in the ascending order then what will be the worst case time complexity of (i) search(T, x) (ii) findMinimum(T). function. — 4M

6. Write the procedure to delete a node in the doubly link list. — 6M

7. Explain the case where we delete the node with right child but its right child doesn't have left child — 8M

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

END SEMESTER EXAMINATION, NOVEMBER 2016

IT200:DATA STRUCTURE AND ALGORITHMS

Class: III SEM B.TECH (IT)

Date: 22/11/2016

Time: 3 Hrs.

Marks: 80

Register No. | 1 | 5 | 1 | T | 2 | 4 | 1 |

NOTE: Answer all Questions to the Point only

1. a) Solve the following Recurrence Relation:

   $T(n)=3T(n/2)+n^2$, $T(1)=1$ 4

   b) Find the Time Complexity of the Merge Sort Algorithm using Recurrence Tree Method and Master Theorem. 6

2. a) Construct a Binary Tree for the following given Traversals:

   Pre-Order: ABDGCEHLF

   In-Order: DGBAHELCF 4

   b) Convert the following Expression from Infix to Postfix using Stack.

   ((A-(B+C))*D)^(E+F) 3

   c) Evaluate the following Postfix Expression (Illustrate each step).

   1 2 3 + * 3 2 1 - + * 3

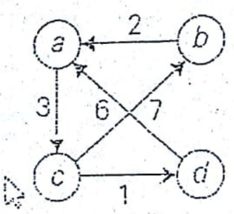
3. a) Explain an Algorithm for Insertion Sort with a suitable Example 5

   b) Sort the following Array using Merge Sort (Illustrate each step). 5

   85, 45, 68, 90, 29, 34, 17

4. a) Briefly Explain Floyd-Warshall Algorithm. 3

   b) Write Shortest Path Matrix and Predecessor Matrix for the following Graph using Floyd-Warshall algorithm (Illustrate each step). 7



5. a) Explain an Algorithm to insert and delete element to and from the Queue. 3

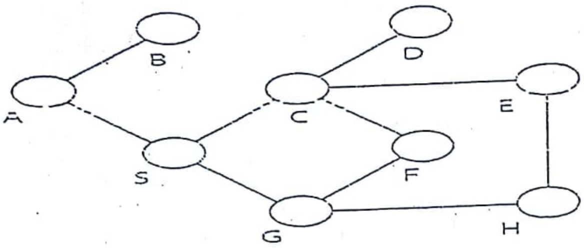
b) Explain an Algorithm to delete Nth node from a Singly Linked List with an Example. 7

6. a) What are AVL Trees? Construct an AVL tree from the List of Elements given below. 4

15, 20, 24, 10, 13, 7, 30, 36, 25

b) Explain Breadth First Search (BFS) Algorithm. 6

Apply BFS on graph given below.

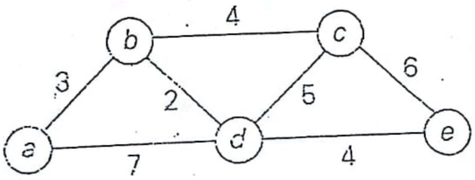


Take S as source vertex.

7. a) A Hash Function f defined as f(Key)=Key mod 7, with linear probing, is used to insert the keys 37, 38, 72, 48, 98, 11, 56 into table indexed from 0 to 6.(Illustrate each step.) 2

b) Explain Dijkstra's Algorithm. 8

Apply Dijkstra's Algorithm for given Graph.



8. a) Build Huffman Tree for the Table Given below

Character	a	B	C	d	e	F
Frequency	12	2	7	13	14	85

Also write Huffman codes for each character. 4

b) What is Greedy Technique? 2

c) Explain Decrease and Conquer with an Example. 4

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

MID SEMESTER EXAMINATION, SEPTEMBER 2017

IT200: DATA STRUCTURES AND ALGORITHMS

Class: III SEM B.TECH (IT)
Date: 11 /09/2017

Time: 1½ Hrs.
Marks: 25

Register No.							
	1	6	I	T	2	0	2

NOTE:
1. Both sides of this paper contain questions.
2. Use Pseudo-code to describe algorithms, unless asked otherwise.

iv) $n < n < n\log n < n^2 < 2^n$

Problem 1:

a) Give the tightest Big-O representation for the following expressions: [2+2= 4 marks]

i) 2+2+2+..n times ii) 1+2+3+..+n iii) $n+(\log n)^2$ iv) $n^{1/2}+n^{\log_3 2}$

b) Compute the runtime of the following function in terms of Big-O notation. Show the steps in your computation:

```
foo(n):
for i = 1 to n
  j = i
  while j <= n
    print (i,j)
    j = 2*j
```

Problem 2: [1+2= 3 marks]

a) In a hash table that uses double hashing, the table size **m** has been chosen to be a power of 2. Assume that the first hash function is **h_1(k) = k mod m.** Design a good offset hash function **h_2(k)** which will ensure that all the table slots will be probed if necessary.

b) Perform the following operations *sequentially* on a (initially empty) hash table of size 5. Take your hash function to be $h(k)=\lfloor 5((0.7k) mod\, 1)\rfloor$ & use linear probing to resolve collisions. Show the new table after each operation:

```
insert(34),insert(13),insert(12),insert(27),delete(13).
```

Problem 3: [2+2+2= 6 marks]

a) Draw the unique binary tree (showing intermediate steps) for each case given their traversals:

i) **Tree 1:** Pre-order: u s p t q v w r ; In-order: s p u q w v t r

ii) **Tree 2:** In-order: a b d e f c g h ; Post Order: a d f e b h g c

If no unique binary tree exists for any of the above case, mention it.

b) What is a complete binary tree? (give a formal definition) If a 14 complete binary tree has n nodes, derive an expression for the number of leaves in terms of n. Show the intermediate steps in your derivation.

c) Write the postfix and prefix form of the expression 10 + 3 * 4 / 6 / 2 – 5.

Problem 4: [2+1+2= 5 marks]

a) What are the three main Queue ADT operations? Briefly explain (illustrate with a suitable example) how you can implement these operations using an array. You do not need to write pseudocode here.

b) *"It is always more efficient to implement Stacks using singly linked lists instead of arrays."* Is this statement True or False? Give reasons for your answer.

c) The *SpecialStack* is a data structure that supports all the usual stack operations like push,pop & top, and an additional operation getMin which returns the minimum element in the SpecialStack. Design this *SpecialStack* data structure such that *all* the operations of SpecialStack take O(1) time. You are allowed to only use the usual Stack data structure and no other data structure like arrays, list, dictionary, etc.

Problem 5: [1+2+1= 4 marks]

a) Mention one advantage and one disadvantage of using arrays to implement Lists.

b) Write pseudocode for the `insert(x,i,L)` operation that inserts element x at the i^{th} position in the doubly linked list L. You may assume that the list has a sentinel node. Take i=0 for the first position in the list.

c) *"In a sorted singly linked list of n integers the Binary Search algorithm can be used to reduce the search time to O(logn)."* Is this statement True or False? Give reasons for your answer.

Problem 6: [3 marks]

Write Python code to define a Binary Tree node: Define a class **`BinTreeNode`** with four attributes `parent`, `key`, `left_child` and `right_child`. Write a constructor that initialises all the four attributes to None. Define a function **`height`** within the class **`BinTreeNode`** that computes and returns the height of the sub-tree rooted at that node.