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HERITAGE INSTITUTE OF TECHNOLOGY

First Semester Examination 2014 Session: M.Tech. 2014-2015

Discipline: CSE

Paper Code : CSEN5104 Paper Name: Advanced Problem Solving & Programming

Time Allotted : 3 hrs Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E,taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: 10 x 1=10

(i) An insertion sort program running on a PC took 20 secs to sort 200 names. Approximately how many names will it be able to sort in 80 secs?

(a) 300 (b) 400 (c) 600 (d) 800

(ii) When run on an array of n keys, the heapsort algorithm has a worst-case time complexity of

(a) $O(n^2)$ (b) O(n) (c) O(n lg n) (d) O(lg n)

(iii) What is the best case and worst case search time for a Binary Search Tree consisting of n nodes?

(a) O(n),O(n) (b) O(log n),O(n)
(c) O(log n),O(log n) (d) O(1),O(log n)

(iv) A queue is an appropriate data structure in a program that implements

(a) depth-first search (b) breadth-first search
(c) inorder tree traversal (d) heapsort

(v) Let T be a binary search tree that has n nodes. A pre-order tree traversal algorithm when run on T will take time proportional to

(a) n (b) lg n (c) n lg n (d) n^2

(vi) To sort three integers using pair wise comparisons, the total number of comparisons in the worst case will be

(a) 6 (b) 4 (c) 3 (d) 2.

(vii) The maximum number of keys that can be inserted into a hash table of size m using open addressing with linear probing

(a) is equal to m (b) is greater than m
(c) is less than m (d) does not depend on m.

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(viii) The number of distinct triples (p, q, r) such that: i) p, q and r are integers; ii) $p \leq q \leq r$; iii) $p + q > r$; iv) $p + q + r = 14$; is

(a) 1 (b) 2 (c) 3 (d) 4

(ix) You have a following code snippet:

```
for  i:= 1 to n do:
    for j:=  1 to m do:
        A[i,j] := A[i-1,j] + x[i,j];
```

What is the optimum size of the A matrix?

(a) n x m (b) m x n

(c) 2 x m (d) None of the above

(x) What will be the output of the following C++ code?

```
class Parent{
Public:
Parent() { }
~Parent() {
cout << "I  am parent
destructor"<<endl; }
        };
```

```
class Child: public
Parent {
public:
Child() { }
~Child()
{ cout<<"I am child
destructor"<<endl; }
};
```

```
void main() {
Parent *p[2] ;
Parent * p1 = new Parent;
Child  *c1 = new Child;
p[0] = p1;
p[1] = c1;
for (int i=0 ; i< 2; i++)
        delete p[i];
        }
```

(a) I am parent destructor
I am child destructor

(b) I am parent destructor
I am parent destructor

(c) I am parent destructor
I am child destructor
I am parent destructor

(d) I am parent destructor
I am parent destructor
I am child destructor

Group - B

2 .(a) Write an algorithm for reversing a (singly linked) linked list. Give an example.

(b) Implement a queue with the help of two stacks. In particular show how your "enque" and "deque" operations look like. You may assume that pop() operations for the two stacks are already available.

(c) You are given a matrix A with a peculiar property that exactly one element in a row or a column can be 1. Ex: if A[3,5] = 1, then there cannot be any 1 anywhere in row 3 and column 5. All other elements in the matrix is 0.

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i) Suggest a mechanism to store such a matrix with n rows and n columns into a one dimensional array B of size n.
ii) Can you define an efficient way to handle matrix addition and multiplication of such peculiar matrices? 3 + 3 + (2 + 4) = 12

3.(a) The following arithmetic statement given in infix notation is to be converted into the Polish postfix notation using a stack:

$$g = a + b * c - d \wedge e + f$$

The binary arithmetic operators **+ - * /,** have their usual meaning; '**^**' (caret) represents exponentiation and '**=**' the assignment operator. Single characters represent variables. Explain how the conversion into the postfix notation can be accomplished.

(b) Suppose the current values of the variables are as follows:

Variable	a	b	c	d	e	f
Value	6	5	4	3	2	1

Explain how the Polish postfix expression obtained above can be evaluated, and the value of *g* determined with the help of a stack.

(c) The given arithmetic statement is now changed to the one given below:

$$g = (a + b) * c - d \wedge (a + c)$$

How can this statement be converted by the use of a stack into parentheses-free postfix notation? In what ways do we need to modify the procedure described in part a) above? 4+4+4=12

Group – C

4.(a) Explain with the help of a diagram what a B-tree of order 5 looks like. Why are B-trees used for storing data in secondary storage?

(b) Construct a B-tree of order 5 with the following sequence of keys:
10,70,60,20,110,40,80,130,100,50,190,90,180,240,30,120,140,200,210,160
Now delete key 180 from the tree just constructed. (2+2) + (6+2) = 12

5.(a) Construct a height-balanced (AVL) tree with the input sequence of keys given below:
49 37 68 51 15 22 55 70 34 23 12 60
Explain clearly how you maintained the height-balanced property during the insertion process.

(b) Now construct a red-black tree (RB) with the same set of keys given in part (a). (4+2) + 6 = 12

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Group – D

6.(a) Assume a Hash table of size 12. You are using Open Addressing scheme. The Hash function is n mod 12, where n is the value of the element to be processed. Show the configuration of the Hash table when the following values are to be inserted in sequence:1, 13, 2, 3, 5. Also what is the average search time to find an element present in the Hash table?

(b) There are n bit vectors given. Two bit vectors can be in the same cluster if they differ by less than three bit positions (also called the distance between bit vectors).
Ex: 0011 and 0010 can be in the same cluster but 0011 and 0100 cannot be in the same cluster.
Also if x and y belong to the same cluster and z is at less than three distance from x but not so for y, then z will be in the same cluster as x and y.
You can write a O(n*n) algorithm easily to find out the pairwise distance between bit vectors and cluster them. But when n is very large (say 10 million or more) this approach will take many minutes if not hours. Suggest a more efficient way to find the final clustering between these n elements and comment on the time complexity of your algorithm. (3 + 3) + 6 = 12

7.(a) Determine what the following recursive C function computes, and then write an iterative function in C or C++ to compute the same function. Assume n is a non-negative integer.

```
int fn(int n)
    {
      if (n == 0)
            return (2);
      return (2 * n * fn(n-1));
    }
```

(b) Write an iterative function in C or C++ to evaluate a **^** b by repeated multiplication. Here a and b are non-negative integers, and '**^**' indicates exponentiation.

(c) A function g() is defined with the positive integers as domain as follows:

g(1) = 2
g(2) = 3
g(n+2) = 4 * g(n) - g(n+1) for n ≥ 1

Write a recursive program in C or C++ to compute g(n) for any positive integer n.
Manually compute the value of g(n) when n = 10. 4 + 4 + (2+2) = 12

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Group - E

8.(a) You have to create a Doubly linked list. Design a data structure of your choice for this purpose and implement the same using C++. In particular show the constructor, destructor and pointer manipulation methods.

(b) WAP in C++ with the following specifications:

I. Create a class Parent with the following methods:
Parent(int age) :- sets the "age" member inside Parent
Display() :- outputs "Inside parent()" & age

II. Create a class Child with a constructor accepting "age" as parameter, which sets the "age" member variable and also the method
Display() :- outputs "Inside child()" & age

III. Create a pointer to base, and add to this a list n number of newly and dynamically created Parent and Child objects randomly (means you can randomly create the Parent and Child objects at will).

IV. Traverse the above list and call "Display()" method on each individual elements of the list.

V. Now repeat IV) this time making "Display()" a virtual function, Is there any difference with IV) .

VI. Delete the created list above.

VII. Now create virtual destructors inside Parent and Child and repeat VI). Is there any difference?

5+ (7 x 1) = 12

9.(a) Create a linked list class in C++ with suitable methods in it.

(b) Implement methods in this class so that the sorted property is always maintained.

(c) Suppose a class A has a virtual function defined inside it. It has a set of superclasses and a set of subclasses. Explain why the effect of "virtual" specifier is available to only the subclasses and not to the superclasses.

5 + 4 + 3 = 12