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Course Code: CS1004
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Course Title: Data Structures and Algorithms
Category: Core
Instructor: Dr. Ram Prasad Padhy, Dr. Jaishree Mayank
Maximum Marks: 30

Instructions to students:

- This question paper contains *four*(4) pages. All questions are compulsory.
- All parts of a question should be written on the same place on the answer sheet.
- All the answers should be written on the provided answer sheet only. DO NOT WRITE ANYTHING ON THE QUESTION PAPER. DO NOT SUBMIT THE QUESTION PAPER.

1. Answer the following questions. (1 x 6 = 6)

(a) $T(n) = 3T(\frac{n}{2}) + \frac{n^2}{\log n}$. What is the complexity of an algorithm which follows the given recurrence relation?

(b) Can we implement binary search in a one-way linked list? Justify your answer.

(c) What is the complexity of the below code snippet?

```
void Function(int n){
  int i, count = 0;
  for(i=1; i<n; i++)
    count++;
}
```

(log log n)

(d) A polynomial is given as: $15x^3y^2 + 4.712x^2y + 3xy^2 + 9xy + 23$. Represent it using a linked list.

(e) Let $f(n) = \sqrt{\log n}$ and $g(n) = \log(\log n)$. Which one of the following is TRUE and why?

- f(n)=O(g(n))
- g(n)=O((f(n))

(f) What does the following function print for a given Linked List with first node as **head**?

```
void fun(struct node* head)
{
  if(head == NULL)
    return;
  fun(head->next);
  printf("%d ", head->data);
}
```

2. Answer the following MCQ questions. (1 x 5 = 5)

(a) Arrange the given complexity functions in terms of their decreasing rates of growth. (Highest rate of growth first) — (a) 2^n (b) nlogn (c) n^2 (d) $\log^2 n$

(i) a > c > d > b

PTO...

olynomial for A. Prove that characteristic polyno (3)

(ii) a > b > c > d
(iii) b > c > d > a
(iv) b > d > a > c
(v) None of the options

(b) Which of the following operations is performed more efficiently by doubly linked list (two-way) than by linear linked list (one-way)?
(i) Deleting a node whose location is given
(ii) Searching an unsorted list for a given item
(iii) Printing the value of each node of the list
(iv) Traversing the list to process each node
(v) None of the options

(c) Consider a singly one-way linked list of the form where **Head** points to the first element in the linked list and **Last** points to the last element in the list. The time complexity of which of the following operations depends on the length of the list?
(i) Delete the last element of the list
(ii) Delete the first element of the list
(iii) Add an element after the last element of the list
(iv) Interchange the first two elements of the list
(v) None of the options

(d) What is the worst case complexity of finding a word in an English dictionary of n pages?
(i) O(n)
(ii) $O(n^2)$
(iii) O(nlogn)
(iv) O(logn)
(v) None of the options

(e) What is the size of the below node structure in a 64-bit system?

```
struct student{
  char* name;
  int roll_no;
  char grade;
  struct student* next;
};
```

(i) 13
(ii) 10
(iii) 18
(iv) 14
(v) None of the options

3. Answer the following questions. (2 x 5 = 10)

(a) Find the complexity of finding n elements of the Fibonacci series, solved using recursion?

(b) Solve the the below recurrence relation.

$$T(n) = \begin{cases} 2T(n-1) - 1, & \text{if } n>0 \\ 1, & \text{otherwise} \end{cases}$$

(c) Consider an array **A** of size 30×9 . Suppose the base address of **A** is 7000 and data type is of 3 bytes. Compute the location of **A**[18, 7] using both column-major and row-major order.

(d) Write the missing statements in the below code and also mention what operation this code performs?

```
p=head, q=NULL;
k=0;
while((p !=NULL) && (k < position-1))
{
  (a) ____________
  (b) ____________
  (c) ____________

}
if(p==NULL)
  Print("Position does not exist");
else
{
  q->next=p->next;
  (d) ____________
}
```

Operation ——— on which kind of ——— List.

(e) Find the upper bound for the below Test(n) function?

```
Test(n)
{
    for (i=1; i< n; i++)
    {
        p=0; q=0;
        for(j=n; j>1; j=j/2)
        {
            ++p;
        }
        for(k=1; k<p; k=k*2)
        {
            ++q;
        }
    }
}
```

4. Answer the following questions. (3 x 3 = 9)

(a) For the given node structure, let **head** points to the first node of a linked list.

```
struct node{
  int  data;
  struct node *link;
}
```

Write pseudo-code/algorithm and explain with an example for the following operations.

- Convert a given one-way singly linked list to circular linked list.
- Given a circular singly linked list, exchange the first and the last node.

(b) Let an array **A** stores the memory locations of **N** consecutive words of an English dictionary. Write an efficient algorithm/pseudo-code to search for the memory location of a given word **WORD** in the array. What are the best, worst and average case complexities for the algorithm?

(c) For the function **Func(n)** given in the next page,

- Write the recurrence relation.
- Solve the recurrence using iterative method and find the bound.
- Can O(n) be the bound for the above function? Prove with the help of substitution method.