DS – ASSIGNMENT – 1
DATE : 6 / 9 / 24

SUBJECT CODE : CS2013

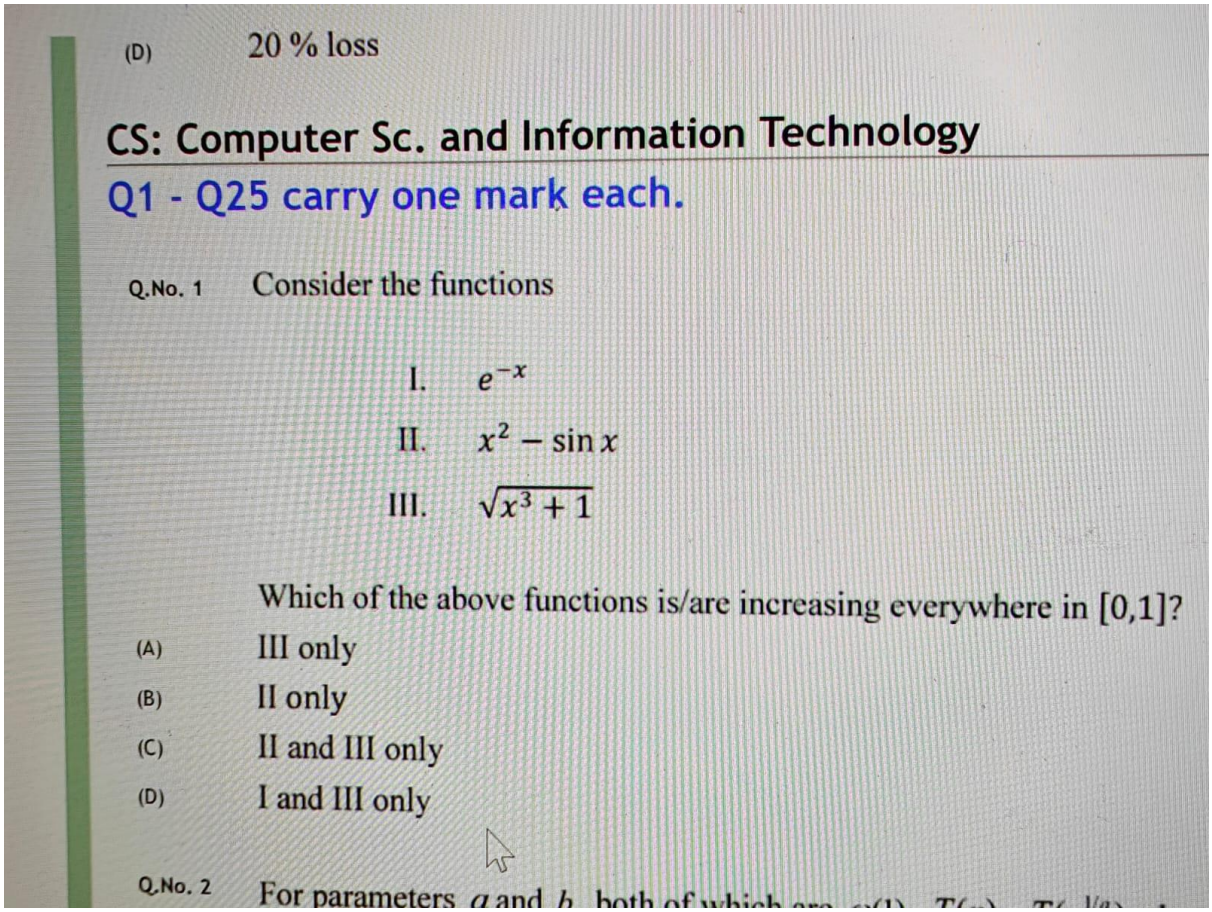
SUBMITTED BY -:

AYUSH PANDA

ROLL NO -: 123CS0202

GATE - 2020

(1)



(D) 20 % loss

CS: Computer Sc. and Information Technology

Q1 - Q25 carry one mark each.

Q.No. 1 Consider the functions

I. e^{-x}

II. $x^2 - \sin x$

III. $\sqrt{x^3 + 1}$

Which of the above functions is/are increasing everywhere in [0,1]?

(A) III only

(B) II only

(C) II and III only

(D) I and III only

Q.No. 2 For parameters a and b both of which

Ans : (A)

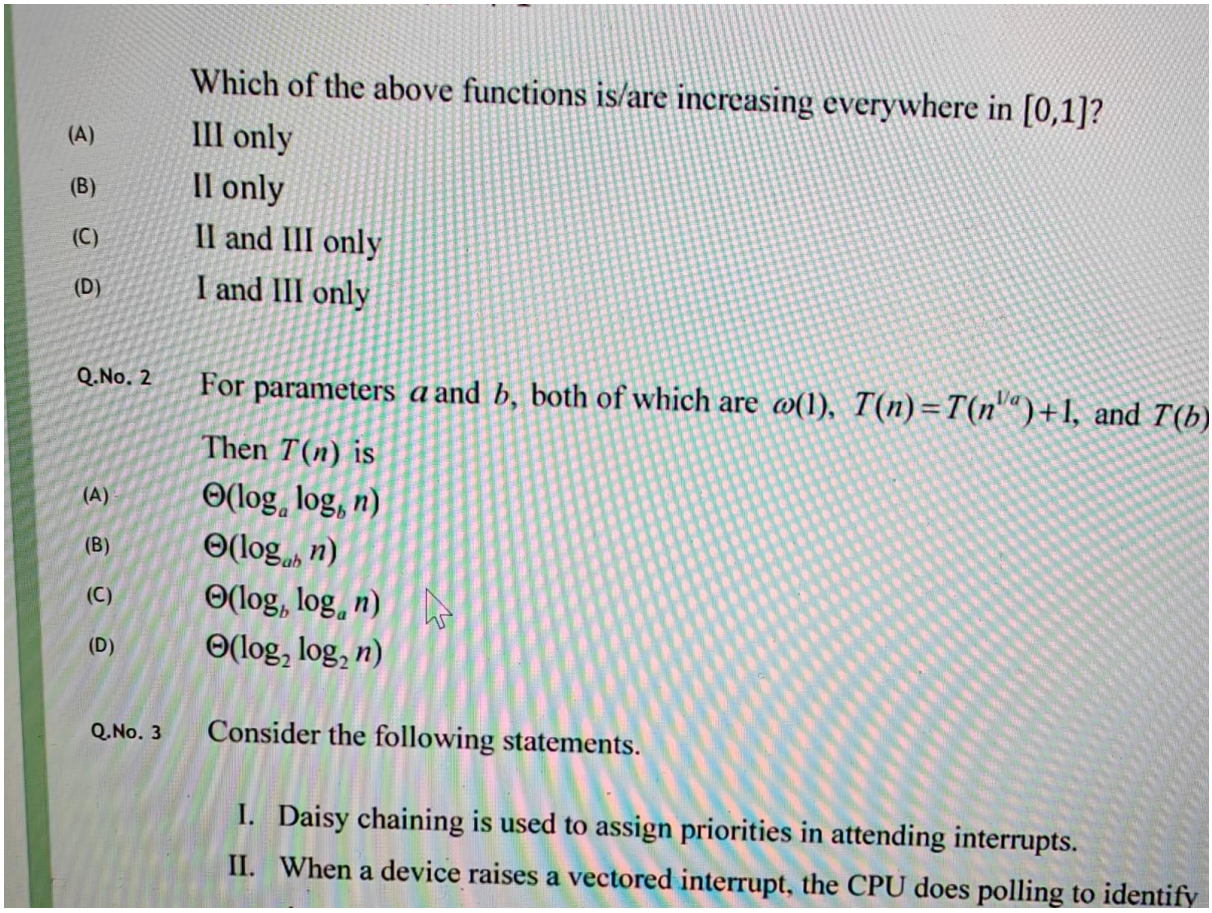
d e^(-x) / dx = -e^(-x) < 0 , Hence it's a decreasing function .

d (x^2 - sinx) / dx = 2*x – cosx

inspecting on intervals , its not purely increasing on [0 , 1] as double

derivative for above is always positive .

sqrt(x^3 + 1) => x^3 +1 => x^3 ie increasing in [0 , 1] .

(2) 

Which of the above functions is/are increasing everywhere in [0,1]?

(A) III only

(B) II only

(C) II and III only

(D) I and III only

Q.No. 2 For parameters a and b, both of which are $\omega(1)$, $T(n) = T(n^{1/a}) + 1$, and $T(b)$

Then $T(n)$ is

(A) $\Theta(\log_a \log_b n)$

(B) $\Theta(\log_{ab} n)$

(C) $\Theta(\log_b \log_a n)$

(D) $\Theta(\log_2 \log_2 n)$

Q.No. 3 Consider the following statements.

I. Daisy chaining is used to assign priorities in attending interrupts.

II. When a device raises a vectored interrupt, the CPU does polling to identify

Ans : (A)

T(n) = (T(n ^(1/a)) + 1 ; n!= b

(1 ; n = b

= (T(n^(1/a^(k))) + k ; n!=b

(1 ; n = b

For (n ^ (1 / a ^(k)) = b)

Taking log on both sides -:

a ^ (-k) * logn = logb

k = logalogb(n)

So for T(n) = T(b) + logalogb(n)

= 1 + logalogb(n)

larger than the size of the incoming IP packet.

Which of the above statements is/are TRUE?

(A) I and II only

(B) I only

(C) II and III only

(D) II only

Q.No. 16 What is the worst case time complexity of inserting n elements into an empty linked list, if the linked list needs to be maintained in sorted order?

(A) $\Theta(n)$

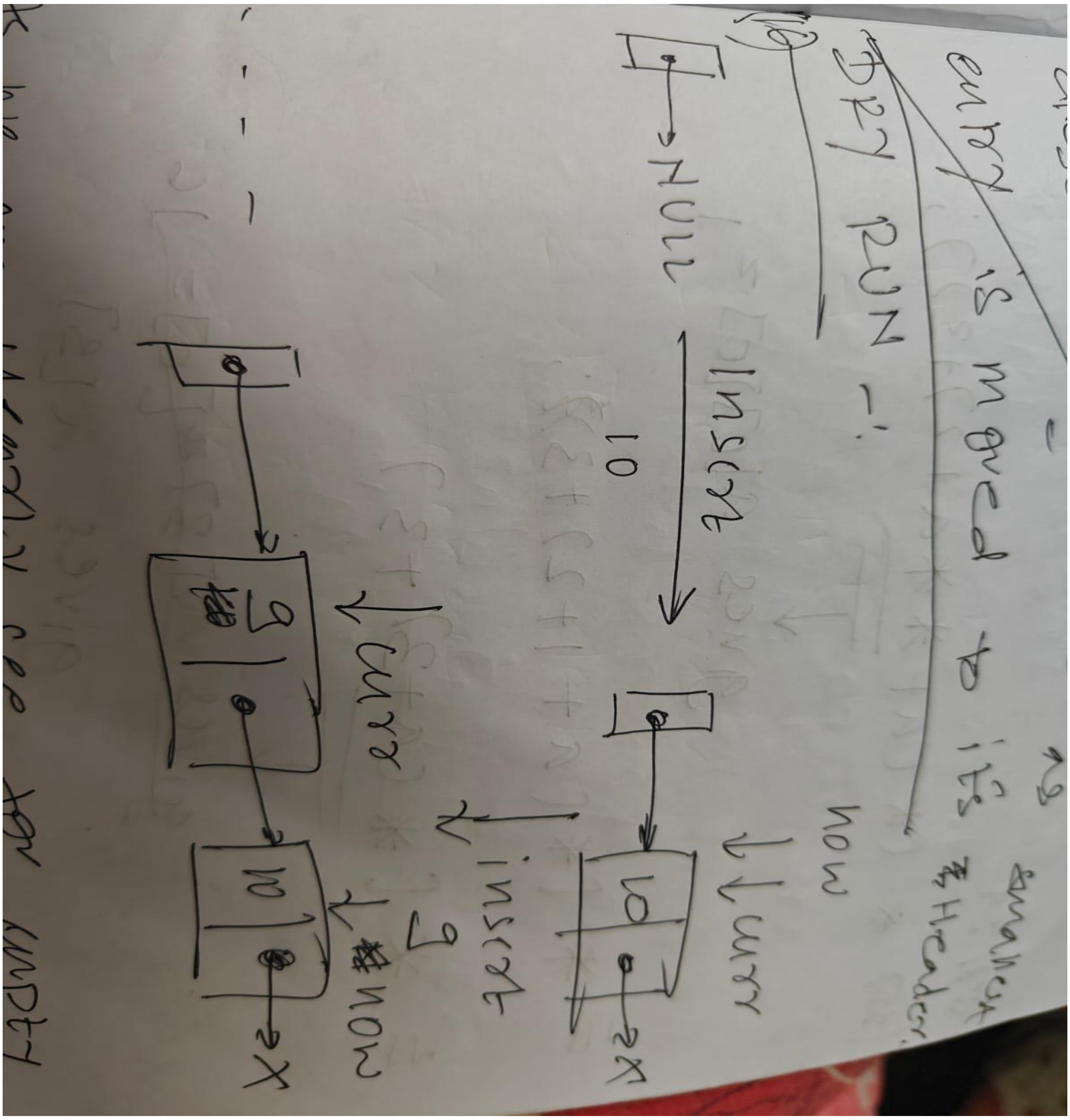
(B) $\Theta(n \log n)$

(C) $\Theta(n^2)$

(D) $\Theta(1)$

Q.No. 17 Let $\mathcal{R}$ be the set of all binary relations on the set $\{1,2,3\}$. Suppose a relation is chosen from $\mathcal{R}$ at random. The probability that the chosen relation is reflexive (round off to 3 decimal places) is _____.

Q.No. 18 Let G be a group of 35 elements. Then the largest possible size of a subgroup of G other than G itself is _____.



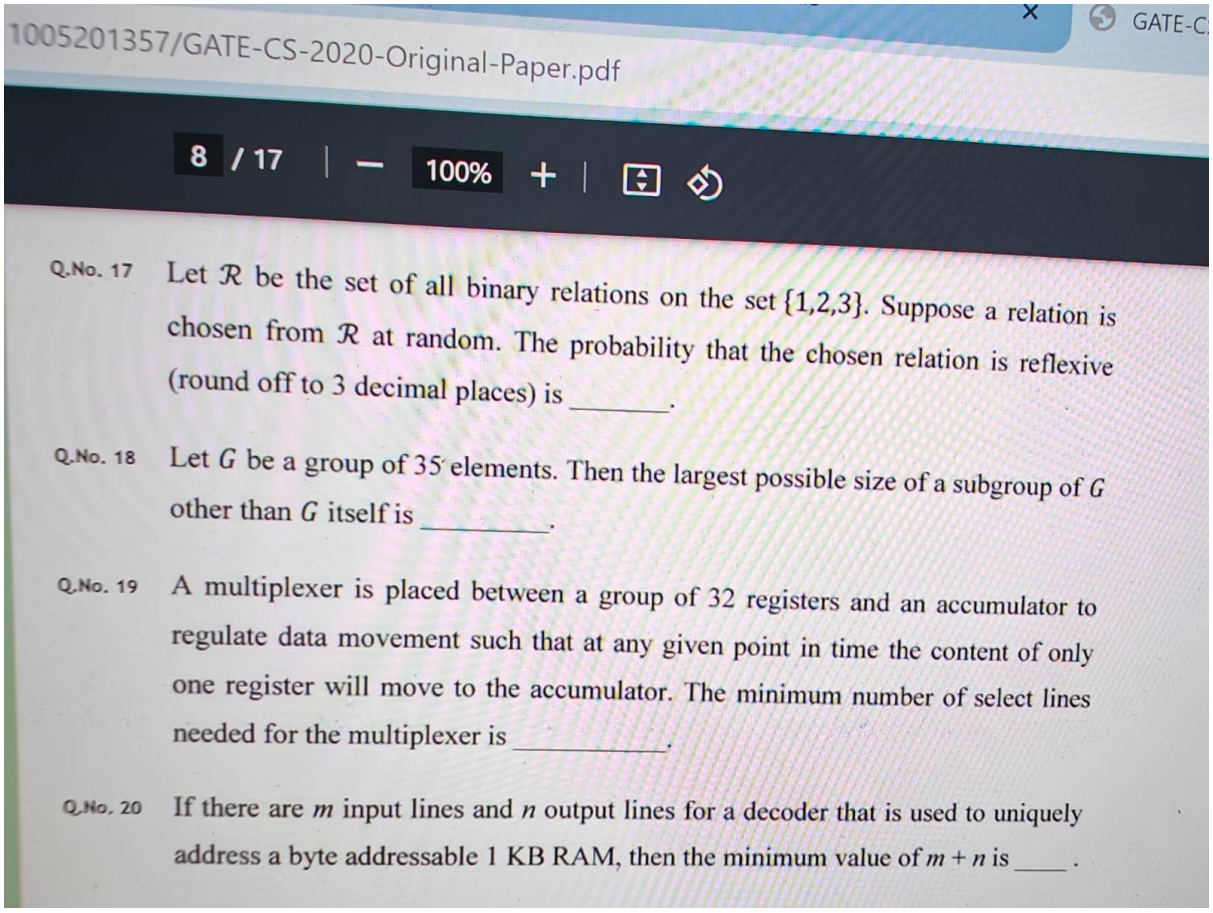
As we can clearly see for empty Linked List , no comparision is needed . but for n = 2 , 1 comparsion is needed , similiarly in worst case scenario we need (n-1) comparisions for nth insertion .

T(n) = 0 + 1 + 2 + 3 ….. (n-1)

= n (n – 1) /2

= O (n^2)

(18)



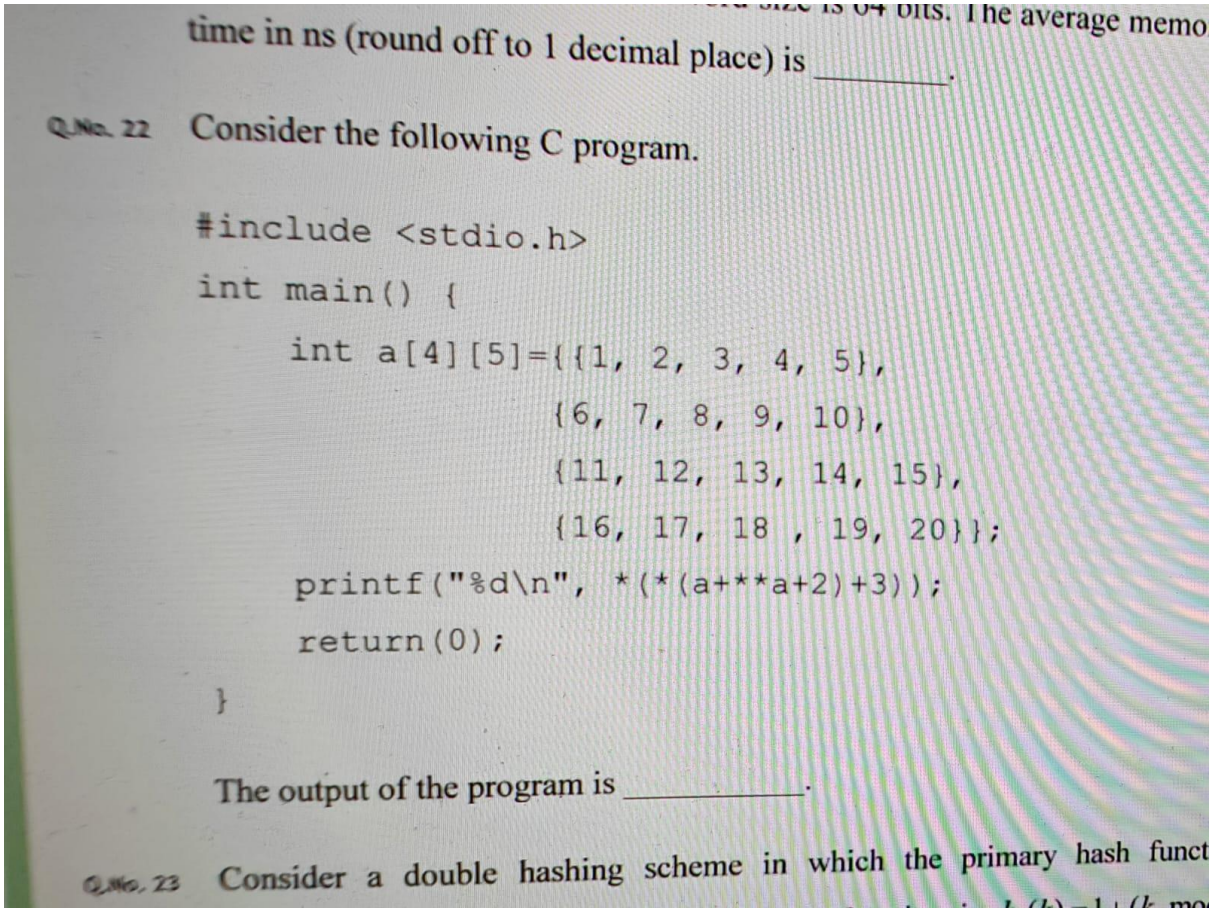
Q.No. 17 Let $\mathcal{R}$ be the set of all binary relations on the set $\{1,2,3\}$. Suppose a relation is chosen from $\mathcal{R}$ at random. The probability that the chosen relation is reflexive (round off to 3 decimal places) is _____.

Q.No. 18 Let G be a group of 35 elements. Then the largest possible size of a subgroup of G other than G itself is _____.

Q.No. 19 A multiplexer is placed between a group of 32 registers and an accumulator to regulate data movement such that at any given point in time the content of only one register will move to the accumulator. The minimum number of select lines needed for the multiplexer is _____.

Q.No. 20 If there are m input lines and n output lines for a decoder that is used to uniquely address a byte addressable 1 KB RAM, then the minimum value of $m + n$ is ____ .

(22)



bits. The average memo

time in ns (round off to 1 decimal place) is _____.

Q.No. 22 Consider the following C program.

```
#include <stdio.h>
int main() {
    int a[4][5]={{1, 2, 3, 4, 5},
                 {6, 7, 8, 9, 10},
                 {11, 12, 13, 14, 15},
                 {16, 17, 18 , 19, 20}};
    printf("%d\n", *(*(a+**a+2)+3));
    return(0);
}
```

The output of the program is _____.

Q.No. 23 Consider a double hashing scheme in which the primary hash funct

19

* (*a(a + **a + 2) +3)

**a gives value of a[0][0]

= *(*(a +1 +2) + 3)

*(a+3) gives value of a[3]

= a[3][3] = 19

Q.No. 45 For $n > 2$, let $a \in \{0,1\}^n$ be a non-zero vector. Suppose that x is chosen uniformly at random from $\{0,1\}^n$. Then, the probability that $\sum_{i=1}^{n} a_i x_i$ is an odd number is _____.

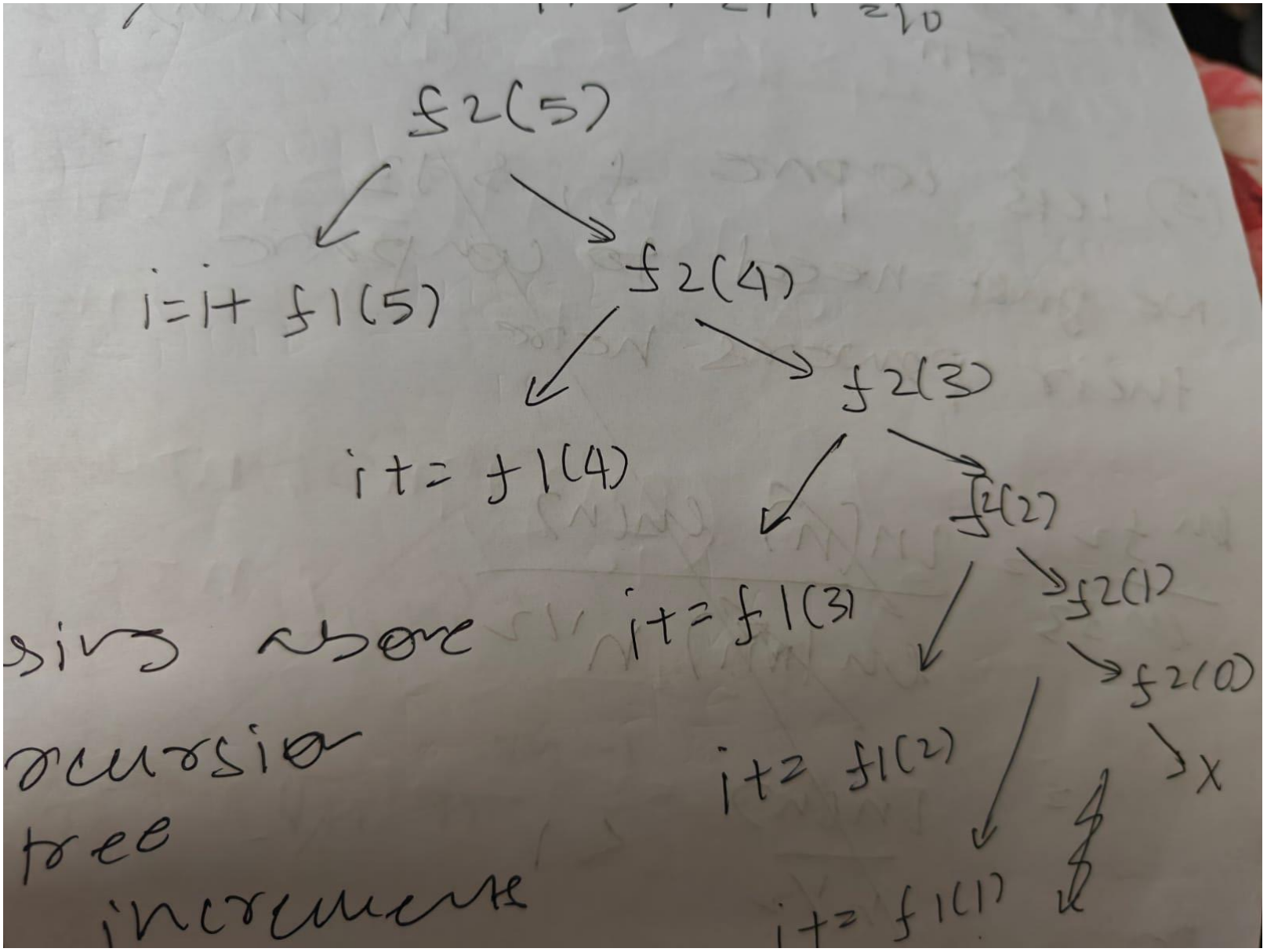
Q.No. 46 Consider the following C functions.

```
int fun1(int n) {
  static int i = 0;
  if (n > 0) {
     ++i;
     fun1(n-1);
  }
  return(i);
}
```

```
int fun2(int n) {
  static int i = 0;
  if (n > 0) {
     i = i + fun1(n);
     fun2(n-1);
  }
  return(i);
}
```

The return value of `fun2(5)` is _____.

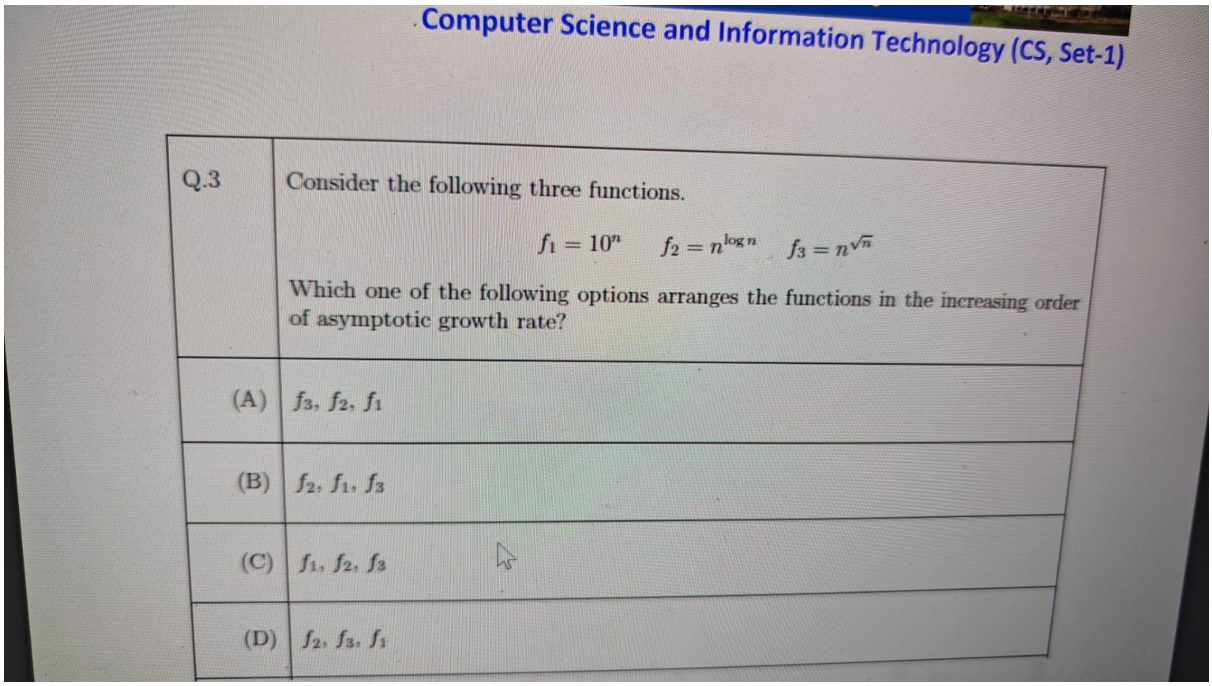
Q.No. 47 Consider the array representation of a binary min-heap containing 1023 elements. The minimum number of comparisons required to find the maximum in the heap


f2(5)
i=i+ f1(5)
f2(4)
it= f1(4)
f2(3)
it= f1(3)
f2(2)
it= f1(2)
f2(1)
it= f1(1)
f2(0)
X
sing above
recursion
tree
increment

Using above recursion tree i increments as 0 + 5 + 9 +12 + 14 + 15 = 55

GATE – 2021

(3)



Computer Science and Information Technology (CS, Set-1)

Q.3	Consider the following three functions. $f_1 = 10^n \quad f_2 = n^{\log n} \quad f_3 = n^{\sqrt{n}}$ Which one of the following options arranges the functions in the increasing order of asymptotic growth rate?
(A)	f_3, f_2, f_1
(B)	f_2, f_1, f_3
(C)	f_1, f_2, f_3
(D)	f_2, f_3, f_1

Taking log of all functions -:

1 – ln(f1) = 10^n (ln10)

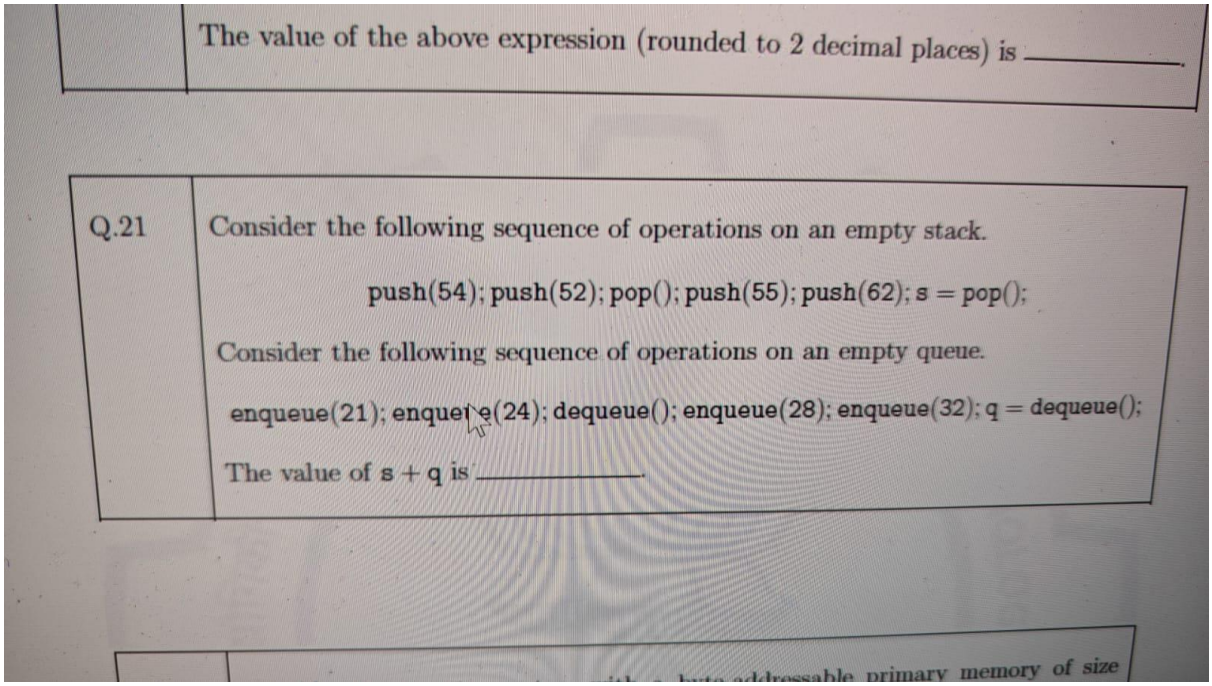
2 – ln(f2) = ln(n) ^ 2

3 – ln(f3) = n^(1/2) ln (n)

Taking their ratios and checking convergence for bigger numbers asymptotic

growth rates for all , rates are given by f1 > f3 > f2 .

(21)



The value of the above expression (rounded to 2 decimal places) is _____.

Q.21 Consider the following sequence of operations on an empty stack.

push(54); push(52); pop(); push(55); push(62); s = pop();

Consider the following sequence of operations on an empty queue.

enqueue(21); enqueue(24); dequeue(); enqueue(28); enqueue(32); q = dequeue();

The value of s + q is _____.

state of stack is given by -:

() -> (54) -> (54,52) -pop-> (54) ->(54,55) -> (54.55,62) -pop->(54,55) . s = 62 (last popped)

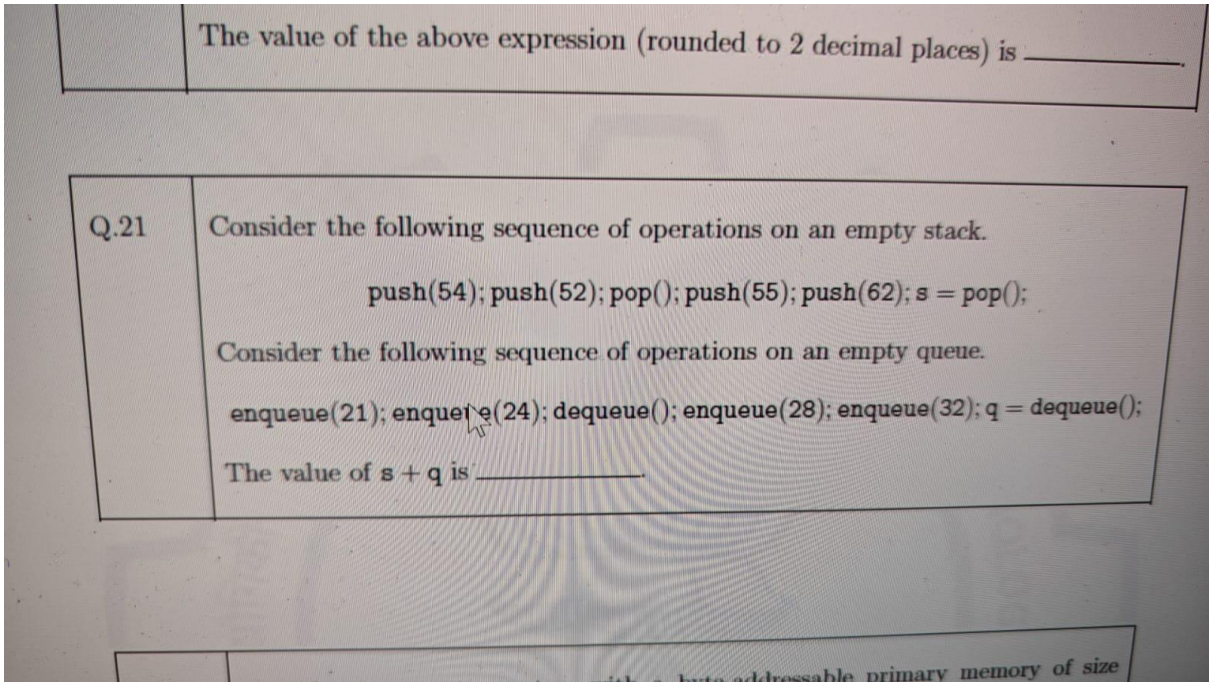
State of queue is given by -:

() -> (21) -> (21 , 24) -deq-> (24) -> (24,28) -> (24 , 28 , 32) -> (28 , 32) q = 24 (last deq)

S + q = 86 .

CS-2

(8)



The value of the above expression (rounded to 2 decimal places) is _____.

Q.21 Consider the following sequence of operations on an empty stack.

`push(54); push(52); pop(); push(55); push(62); s = pop();`

Consider the following sequence of operations on an empty queue.

`enqueue(21); enqueue(24); dequeue(); enqueue(28); enqueue(32); q = dequeue();`

The value of `s + q` is _____

addressable primary memory of size

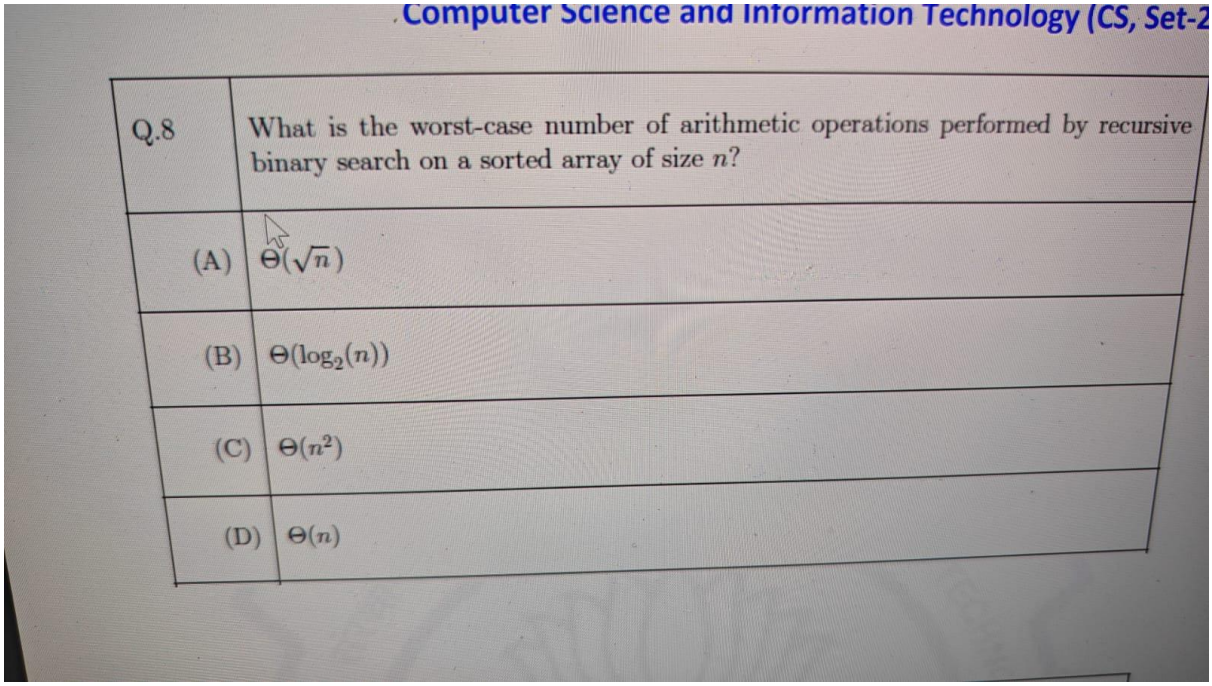
O(log 2 n) (B)

T(n) = T(n/2) + O(1)

If f(n) = O(n ^ logb a) then T(n) = O(n ^ logb a)

Hence T(n) = O(1 * log2 (n)) = O(log2n)

(35)



Computer Science and Information Technology (CS, Set-2

Q.8 What is the worst-case number of arithmetic operations performed by recursive binary search on a sorted array of size n?

(A) $\Theta(\sqrt{n})$

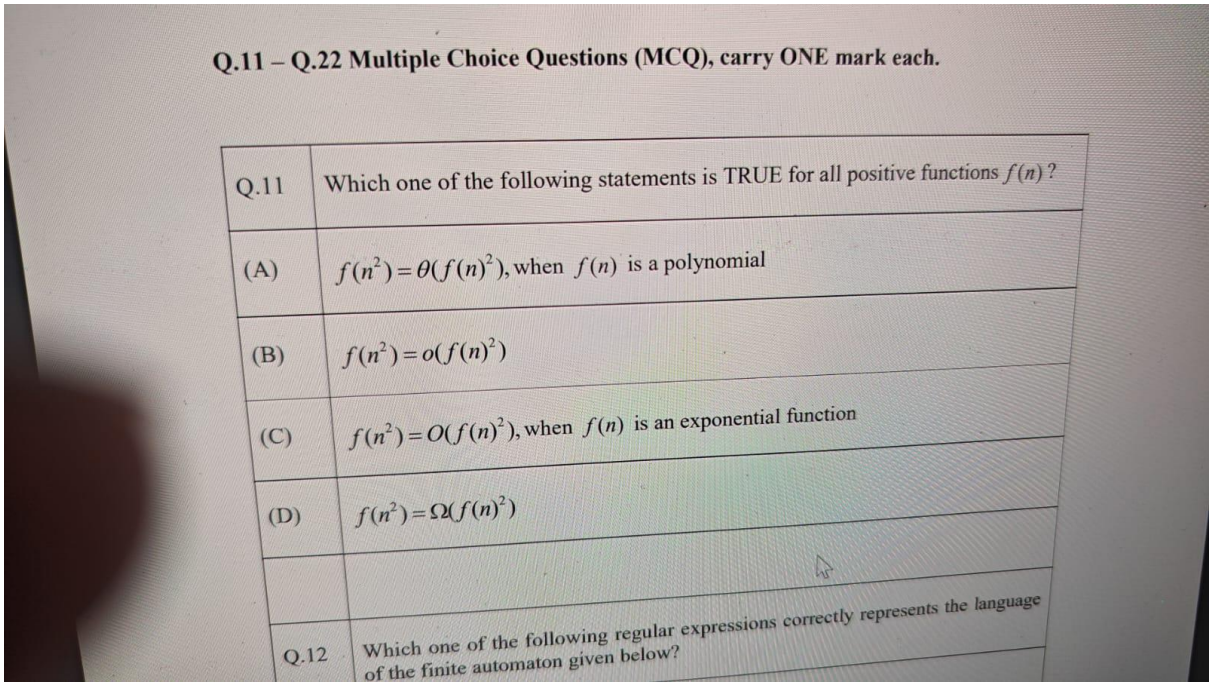
(B) $\Theta(\log_2(n))$

(C) $\Theta(n^2)$

(D) $\Theta(n)$

GATE – 2022

(11)



Q.11 – Q.22 Multiple Choice Questions (MCQ), carry ONE mark each.

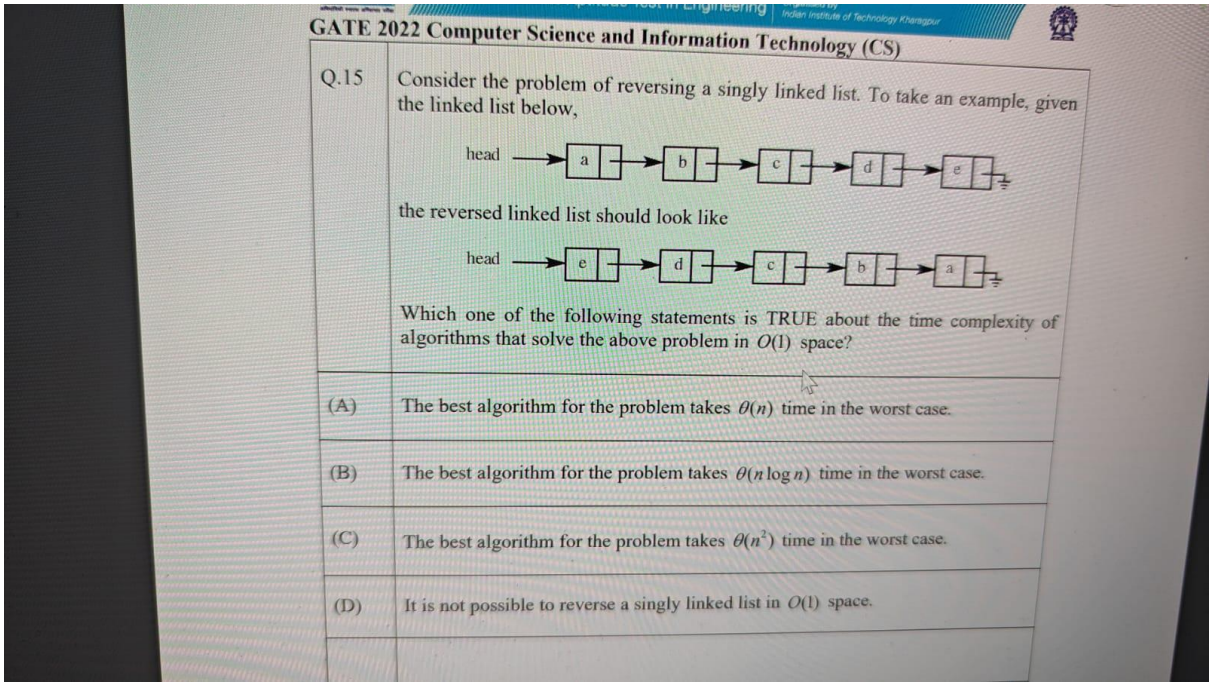
Q.11	Which one of the following statements is TRUE for all positive functions $f(n)$?
(A)	$f(n^2) = \theta(f(n)^2)$, when $f(n)$ is a polynomial
(B)	$f(n^2) = o(f(n)^2)$
(C)	$f(n^2) = O(f(n)^2)$, when $f(n)$ is an exponential function
(D)	$f(n^2) = \Omega(f(n)^2)$
Q.12	Which one of the following regular expressions correctly represents the language of the finite automaton given below?

(A)

f(n^2) = O(f(n) ^ 2)

For polynomial expression as term with highest order gets squared .

(15)



GATE 2022 Computer Science and Information Technology (CS)

Q.15 Consider the problem of reversing a singly linked list. To take an example, given the linked list below,

the reversed linked list should look like

Which one of the following statements is TRUE about the time complexity of algorithms that solve the above problem in $O(1)$ space?

(A) The best algorithm for the problem takes $\theta(n)$ time in the worst case.

(B) The best algorithm for the problem takes $\theta(n \log n)$ time in the worst case.

(C) The best algorithm for the problem takes $\theta(n^2)$ time in the worst case.

(D) It is not possible to reverse a singly linked list in $O(1)$ space.

(A)

Each operation includes temporarily pointing to previous node (or) NULL ,

& moving iterating pointer till the end of linked list making it a O(1)

Process . So for n such process -:

O(operation) = O(1 + 1 + 1 + …. N times)

= O(N)

7 / 41 | − 100% + |

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ATE 2022 Computer Science and Information Technology (CS)

Q.21 What is printed by the following ANSI C program?

```
#include<stdio.h>
int main(int argc, char *argv[])
{
    int x = 1, z[2] = {10, 11};
    int *p = NULL;
    p = &x;
    *p = 10;
    p = &z[1];
    *(&z[0] + 1) += 3;
    printf("%d, %d, %d\n", x, z[0], z[1]);
    return 0;
}
```

(A)	1, 10, 11
(B)	1, 10, 14
(C)	10, 14, 11
(D)	10, 10, 14

(21)

(B)

X value changes from 1 to 10 .

P = &z[1] and finally value changes to 1 .

(43) Q.43 What is printed by the following ANSI C program?

#include int main(int argc, char *argv[])

{

int a[3][3][3] = {{1, 2, 3, 4, 5, 6, 7, 8, 9}, {10, 11, 12, 13, 14, 15, 16, 17, 18}, {19, 20, 21, 22, 23, 24, 25, 26, 27}};

int i = 0, j = 0, k = 0;

for(i = 0; i < 3; i++)

{ for(k = 0; k < 3; k++) printf("%d ", a[i][j][k]); printf("\n");

}

return 0; }

(A) 1 2 3
10 11 12
19 20 21

(B) 1 4 7
10 13 16
19 22 25

(C) 1 2 3
4 5 6
7 8 9

(D) 1 2 3
13 14 15
25 26 27

(A)

All elements are allocated memory successively as per rule 9i + 9j + k .

Since j = 0 , our rule boils down to 9i +k and our matrix is as follows :

1 2 3

10 11 12

19 20 21

(44) What is printed by the following ANSI C program?

#include

```
int main(int argc, char *argv[]){
char a = 'P';
char b = 'x';
char c = (a & b) + '*';
char d = (a | b) - '-';
char e = (a ^ b) + '+';
printf("%c %c %c\n", c, d, e);
return 0;
}
```

(A) z K S

(B) 122 75 83

(C) * - +

(D) P x +

(A) z k s

char c = (p & x) + ‘ * ’

= (80 & 120) + ‘ * ‘

= (1010000 & 1111000) + ‘ * ‘

= 80 + ‘ * ‘

= z

char d = (1010000 | 1111000) – ‘ – ‘

= 120 – ‘ – ‘

= k

Char e = (1010000 ^ 1111000) + ‘ + ‘

= 40 + ‘ + ‘

= s

GATE – 2023

(13) Let SLLdel be a function that deletes a node in a singly-linked list given a pointer to the node and a pointer to the head of the list. Similarly, let DLLdel be another function that deletes a node in a doubly-linked list given a pointer to the node and a pointer to the head of the list. Let n

denote the number of nodes in each of the linked lists. Which one of the following choices is TRUE about the worst-case time complexity of SLLdel and DLLdel?

(A) SLLdel is O(1) and DLLdel is O(n)

(B) Both SLLdel and DLLdel are O(log(n))

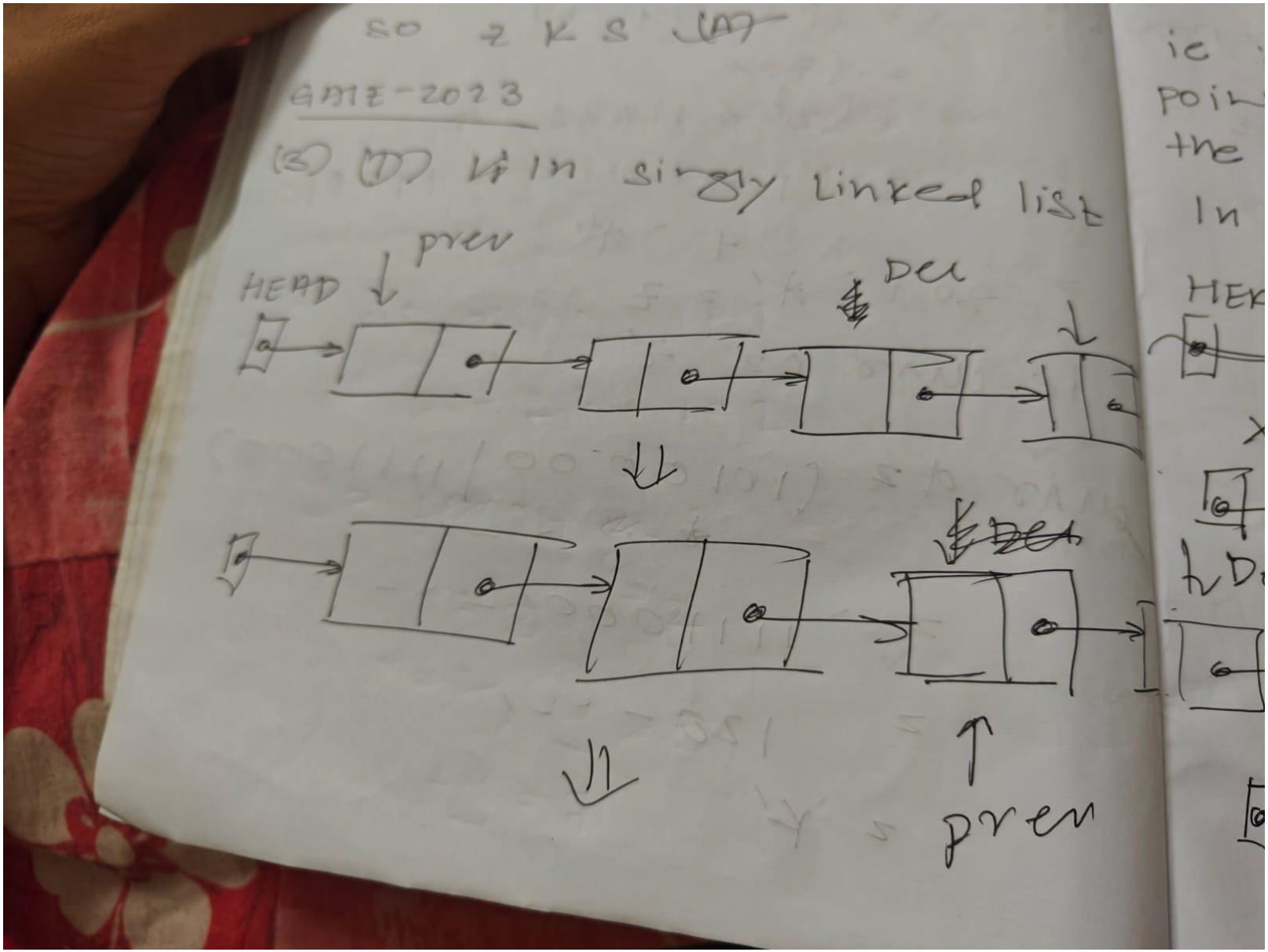
(C) Both SLLdel and DLLdel are O(1)

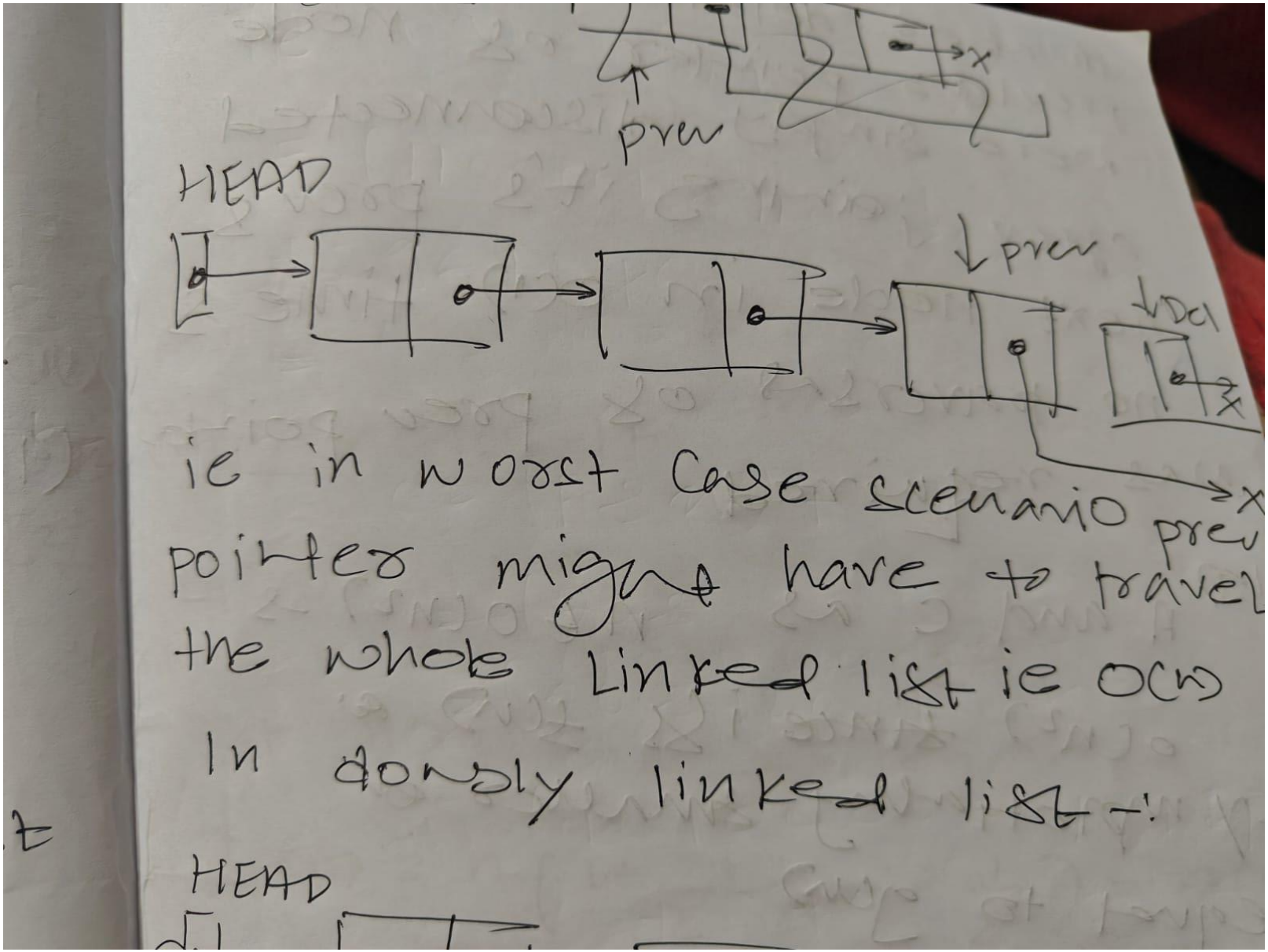
(D) SLLdel is O(n) and DLLdel is O(1)

(D)

In singly linked list in worst case scenario , prev pointer might have to travel

The whole linked list ie O(n) :

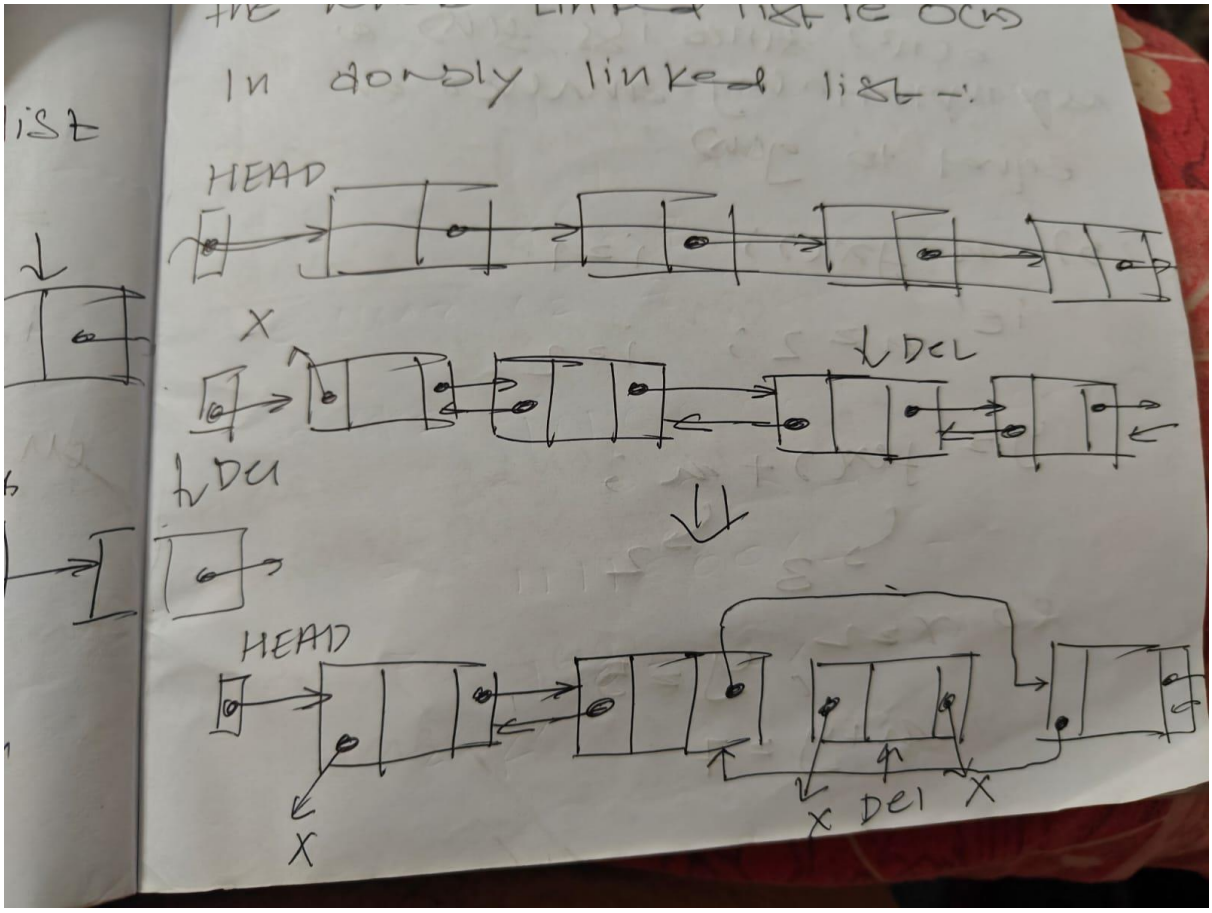

GATE-2023
(B) (D) is in singly linked list
prev
HEAD
Del
Del
prev


prev
HEAD
prev
NULL
ie in worst case scenario prev pointer might have to travel the whole Linked list ie O(n)
In doubly linked list -:
HEAD

In doubly linked list . In above deletion next and previous pointer of node

Were simply disconnected after joining its prev and next node in O(1) time . No

Traversal of prev pointer was required



(29) Let f and g be functions of natural numbers given by f(n) = n and g(n) = n2. Which of the following statements is/are TRUE?

(A) $f \in O(g)$

(B) $f \in \Omega(g)$

(C) $f \in o(g)$

(D) $f \in \Theta(g)$

A and C

As n belongs to O(n^2) .

O(n^2) iff f(n) asymptotically smaller or equal to g(n)

(35)

The integer value printed by the ANSI-C program given below is .

```
#include
int funcp()
{
 static int x = 1;
 x++; return x;
}
 int main(){
 int x,y;
 x = funcp();
 y = funcp()+x;
 printf("%d\n", (x+y));
 return 0;
 }
```

7

X = fx( ) ; i = 1

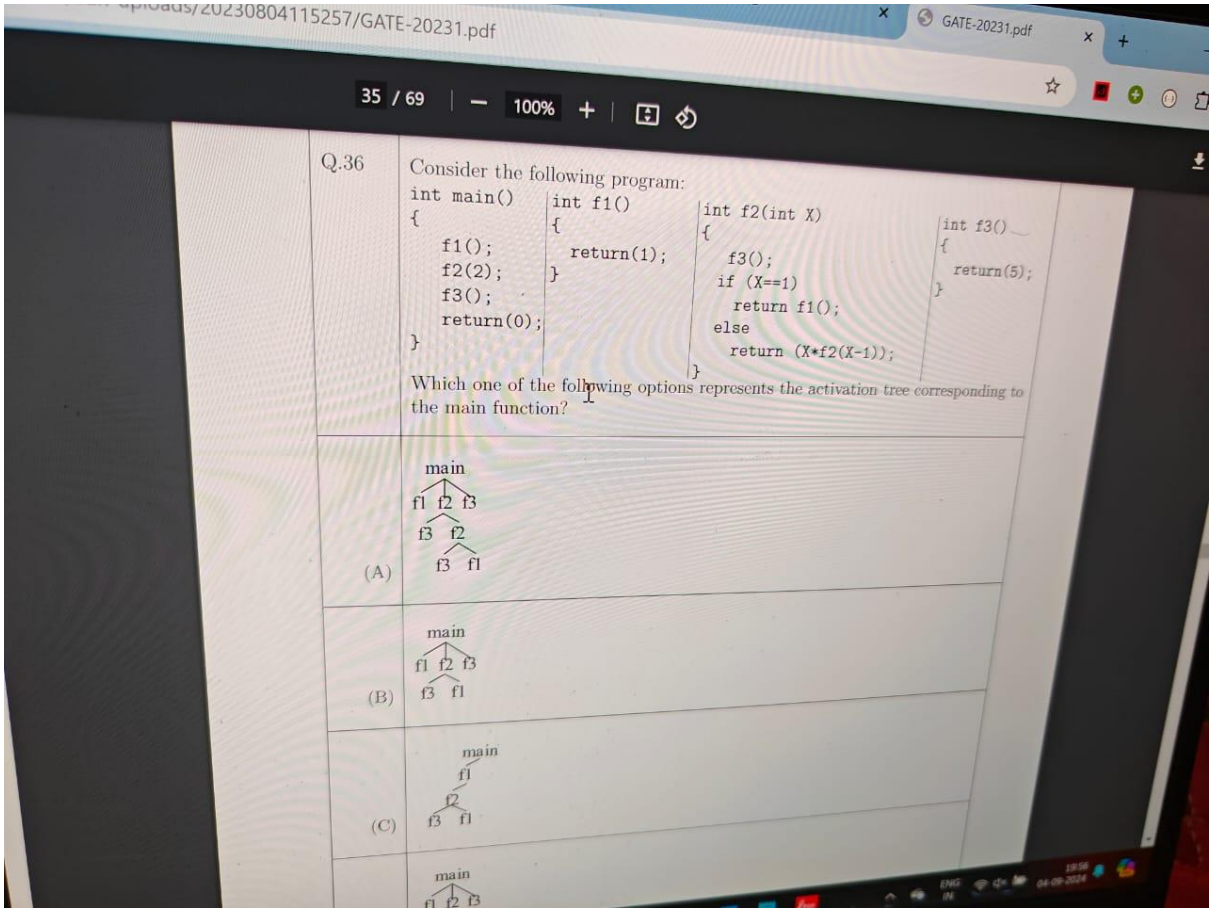
Ie x = 2 ; I = 2

Y = fx() + x ;

3 2

So x = 2 and y = 5 ie x + y = 7 .

(36)



(A)

Main

/ | \

f1 f2 f3

/ \

F3 f2

/ \

F3 f1

(44) (D)

Function -1 -:

f1(n) = n + n/2 + n/(2^2) + ... + n/(2 ^ k)

st n > 2^k ie k = log2n

f1(n) = O(n)

Function – 2 -:

f2(n) = 100n = O(n)

Hence f1(n) = O(f2(n)) (a) & f1(n) = O(n) (d)

F1(n) and f2(n) denotes the number of times x = x+1 was executed

GATE – 2024 CS-1

Q.17 Given an integer array of size N, we want to check if the array is sorted (in either ascending or descending order). An algorithm solves this problem by making a single pass through the array and comparing each element of the array only with its adjacent elements. The worst-case time complexity of this algorithm is

(A) both O(N) and Ω(N)

(B) O(N) but not Ω(N)

(C) Ω(N) but not O(N)

(D) neither O(N) nor Ω(N)

(A) Both O(N) and omega(N)

In either case for worst case scenario we will have to traverse the whole array , as

We cannot be sure of its sorted nature till the very last element check

(18) Consider the following C program:

```
#include int main(){
int a = 6;
int b = 0;
while(a < 10) {
a = a / 12 + 1;
a += b;
}
printf(”%d”, a);
return 0;
}
```

Which one of the following statements is CORRECT?

(A) The program prints 9 as output

(B) The program prints 10 as output

(C) The program gets stuck in an infinite loop

(D) The program prints 6 as output

(C) infinite loop

Value of a always come below 10 in this . Hence it gets stuck in an infinite loop .

a = 6 -> 1 -> 1 -> 1 -> 1 ……. So on

(19) Q.19 Consider the following C program:

#include void fX();

int main(){

fX();

return 0;

}

void fX()

{

char a;

if((a=getchar()) != '\n') fX();

if(a != '\n') putchar(a);

} Assume that the input to the program from the command line is 1234 followed by a newline character. Which one of the following statements is CORRECT?

(A) The program will not terminate

(B) The program will terminate with no output

(C) The program will terminate with 4321 as output

(D) The program will terminate with 1234 as output

(C) program terminates with 4321 as output

(48) Consider the following C function definition. int f(int x, int y) { for (int i=0; i

(B) and (D)

For n = 0 , x is x

N = 1 , 2x + y

N = 2 , 4x + 3y

N = 3, 8x + 7y

.

.

.

N = y-1 ,it becomes (2 ^ (y - 1)) * x + (2 ^ (y – 1) -1) * y

For x = 20 and y = 20 , (2 ^ (19)) * (20) + ((2 ^ 19) – 1) * (20) > 2 ^ 20 .

For x = 20 and y = 10 , (2 ^ (9)) * (20) + ((2 ^ 9) – 1) * (10) < 2 ^ 20 .

CS-2

(35) Let A be an array containing integer values. The distance of A is defined as the minimum number of elements in A that must be replaced with another integer so that the resulting array is sorted in non-decreasing order. The distance of the array [2, 5, 3, 1, 4, 2, 6] is

3

We have to look for longest increasing or decreasing sequence :

[2 , 5 , 3 , 1 , 4 , 2 , 6]

T T T T

T denotes longest sequence ie 2 3 4 6 , so we just have to change (5 , 1 , 2) ie wt = 3 .

(33) Q.33 Consider the following C function definition.

int fX(char *a){

char *b = a;

while(*b) b++;

return b - a;}

Which of the following statements is/are TRUE?

(A) The function call fX(”abcd”) will always return a value

(B) Assuming a character array c is declared as char c[] = ”abcd” in main(), the function call fX(c)will always return a value

(C) The code of the function will not compile

(D) Assuming a character pointer c is declared as char *c = ”abcd” in main(), the function call fX(c)will always return a value

(A) (B) (D)

(A) The function call fX("abcd") will always return a value:

- **TRUE**: The string literal "abcd" is a valid string and is null-terminated. The function will return 4, which is the length of "abcd".

(B) Assuming a character array c is declared as char c[] = "abcd" in main(), the function call fX(c) will always return a value:

- **TRUE**: The array c is initialized with the string "abcd", which is null-terminated. The function will return 4.

(C) The code of the function will not compile:

- **FALSE**: There is nothing in the function that would prevent it from compiling. The code is valid C code.

(D) Assuming a character pointer c is declared as char *c = "abcd" in main(), the function call fX(c) will always return a value:

- **TRUE**: The pointer c is initialized to point to the string literal "abcd". The function will return 4.

(36) Q.36 What is the output of the following C program?

```
#include int main()
{ double a[2]={20.0, 25.0}, *p, *q; p = a; q = p + 1;
printf(”%d,%d”, (int)(q – p), (int)(*q – *p));
return 0;
}
```

(B) 1 , 4

P = a sets the pointer to first element of array ie 20.0 .

q = p + 1 sets q to second element of array a ie 25.0 .

(int) (q – p) = 1 ie they are in adjacent locations .

Int (*q - *p) = 5 ie difference of their values .