INTRODUCTION TO ALGORITHMS(EC351)

ASSIGNMENT-I

Consider the Fibonacci series and solve the following.

Where, fib(k)=fib(k-1)+fib(k-2)

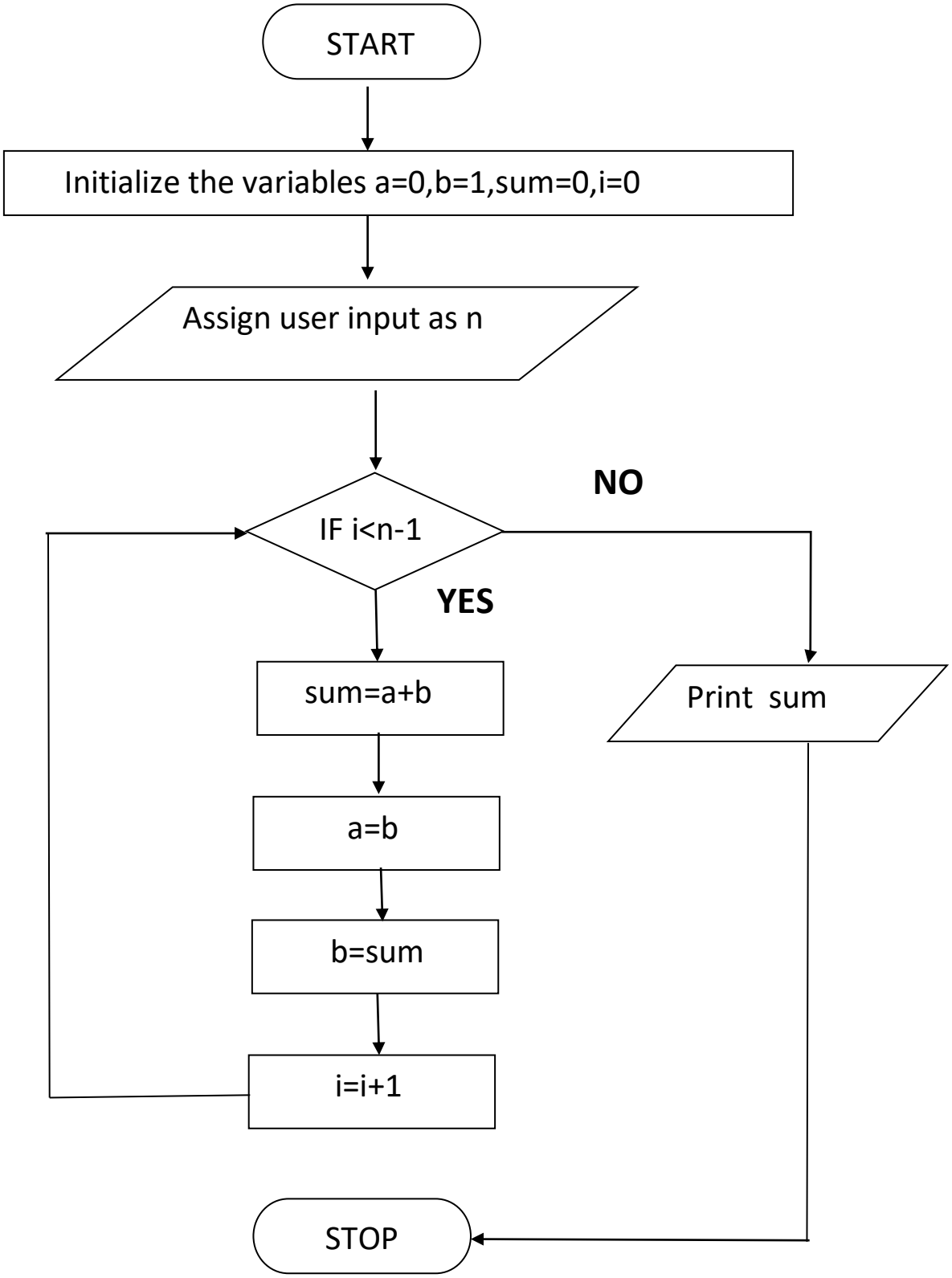
- Draw the flow chart, algorithms in pseudo code for solving fib(5) and fib(500).
- Find out total memory or space required to perform these Fibonacci series computational operations.
- Find out worst case and best case scenarios from the above identified approaches.
- Write a program to compare the actual memory consumed by all the approaches.

Solution:

- Let us consider the input as ‘n’ for which we need to find the element at nth index in fibonacci series.
- We can find the value of nth element in the Fibonacci series (fib(n)) in two ways.

1.Non-recursive method:

Flow chart:



Algorithm:

Step 1: START

Step 2: Initialize three variables a=0, b=1 and sum=0

Step 3: Assign the user input to n

Step 4: Initialize i=0 which acts as a counter variable

Step 5: If i is greater than n-2

THEN: go to Step 11

Step 6: sum=a+b

Step 7: a=b

Step 8: b=sum

Step 9: i=i+1

Step 10: go to Step 5

Step 11: Print the value of sum

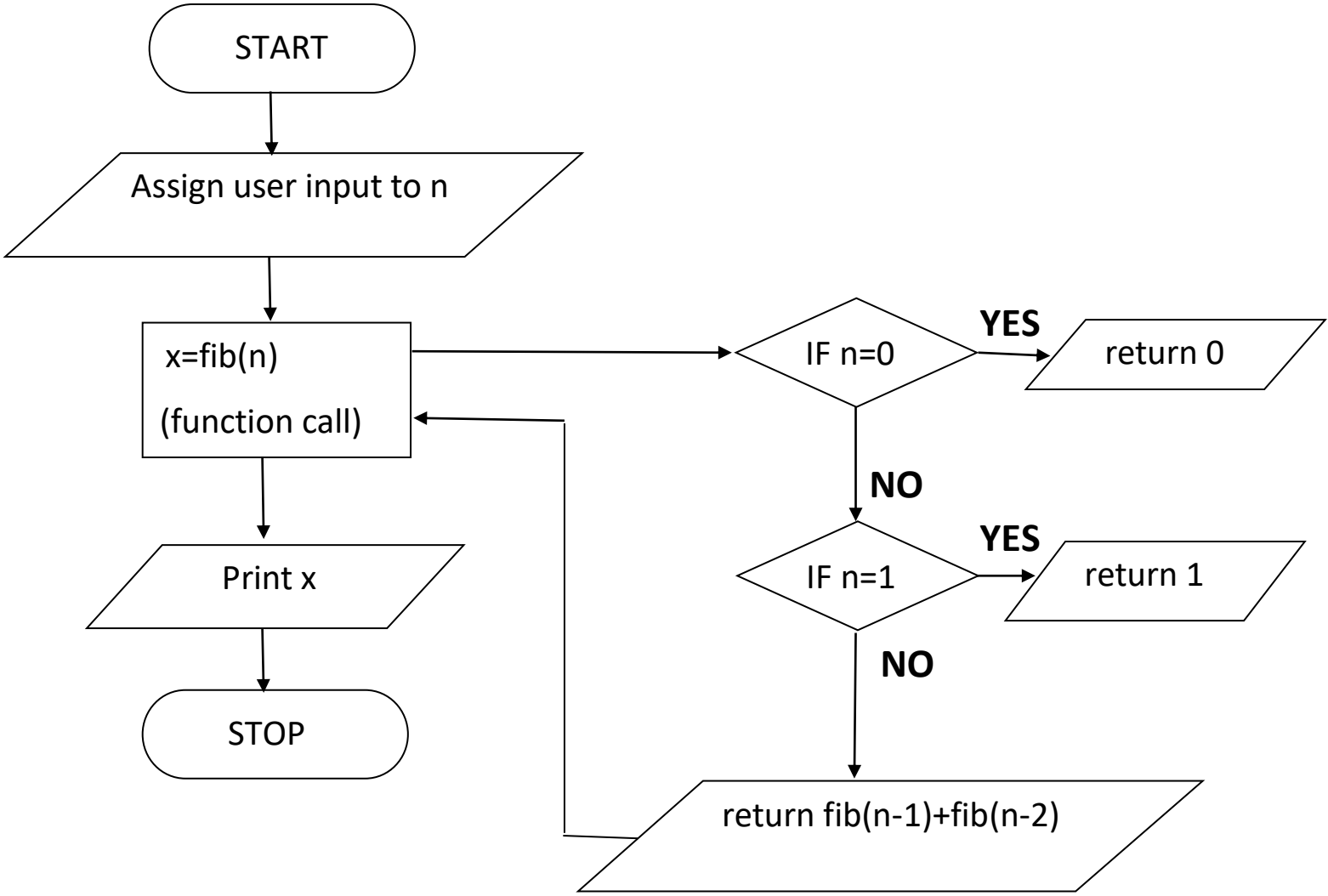
Step 12: STOP

Space Complexity:

- As per this algorithm(non-recursive), the space allocated for the variables a, b, sum, n and i at the beginning is a constant space i.e, 4+4+4+4 bytes).(assuming that int occupies 4 bytes)
- Even if there is loop in the algorithm, the values stored in the variables are just overwriting their values for each iteration.
- Hence there is no extra space allocated. Therefore, the space complexity is O(1).

2.Recursive method:

Flow chart:



Algorithm:

Algorithm for recursive function fib(k):

Step 1: Take the input value k

Step 2: IF k is equal to 0
THEN
return 0

Step 3: IF k is equal to 1
THEN
return 1

Step 4: ELSE
return fib(k-1)+fib(k-2)
ENDIF

Main function:

Step 1: START

Step 2: Assign user input to n

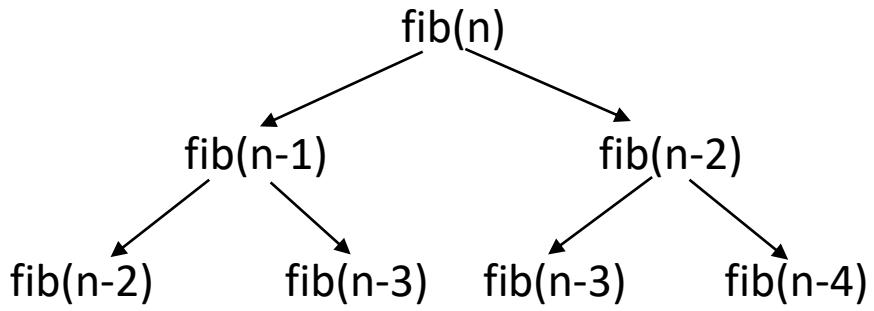
Step 3: Call the function fib(n) and assign the value to a variable x

Step 4: Print the value of x

Step 5: STOP

Space Complexity:

- Here, in this algorithm we are calling the function fib(k) multiple times to get the value of fib(n).
- At each function call, extra memory will be allocated to store the return values in the stack.
- Hence space complexity is decided by that variable space.
- The function executes in the following way-



and so on till there is termination i.e., fib(0) or fib(1) .

- So while executing the function fib(n) the space is occupied by the function in the stack till it find its value (i.e., it calls itself again and again till it terminates).
- Therefore, the space complexity is O(n)*space occupied by each function fib(k).

Space complexity=O(n)*O(1)=O(n)

(Assuming the space occupied by the function is constant i.e., O(1))

❖ ***Based on these two algorithms, we can say that the non-recursive algorithm is the best case scenario and the recursive algorithm is the worst case as its space complexity is more.***