

# Data Structures and Algorithms IT2070

Year two Semester two 2021 September

Online Examination

Sri Lanka Institute of Information Technology

Time: 20 minutes

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## Paper Number 0 (20 marks)

Consider the following recursive sequence of numbers:

1, 3, 6, 10, 15. . . .

- a) Design a **recursive** Python function to produce the above output when a user enters an integer from the keyboard.
- b) Use the loop to run the program and display the correct output until user input -1.
- c) Sample Output:

Enter number:1

Output:1

Enter number:2

Output:3

Enter number:3

Output:6

Enter number: -1

Output: Finished

**Note: 0 marks for non-recursive solutions**

**Upload your answer using given in the course web link “Paper Number 0”**

## Grading Sheet:

- 1) Program is compiling. **2 marks**
- 2) Program is running successfully. **2 marks**
- 3) Program takes the input number as integer. **2 marks**
- 4) Correct implementation recursive function. **6 marks**
- 5) Display the output correctly **2 marks**
- 6) Use of loop correctly **4 marks**
- 7) Include comments and properly indented. **2 marks**
- 8) Plagiarism testing tool results: .....

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## Paper Number 0 (20 marks)

A recursive algorithm for the calculation for the multiplication of two numbers M and n is given below:

```
Multiply (M,n)

if (n = 1)
    return M;

else
    return (M + Multiply(M, n-1))
```

- Write a program in Python to read an integers from the keyboard for M and n.
- Develop a function in python named as multiply and implement the above recursive algorithm.
- Pass the input number as parameter to the function developed and get the multiplication of numbers as output.
- Use the loop to run the program and display the correct output until user input -1.

**Upload your answer using given template to the course web link “Paper Number 0”**

## Grading Sheet:

- 1) Program is compiling. **2 marks**
- 2) Program is running successfully. **2 marks**
- 3) Program takes the input number as integer. **2 marks**
- 4) Correct implementation multiply function. **6 marks**
- 5) Display the output correctly **2 marks**
- 6) Use of loop correctly **4 marks**
- 7) Include comments and properly indented. **2 marks**
- 8) Plagiarism testing tool results:.....

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## Paper Number 2 (20 marks)

Consider the following recursive sequence of numbers:

2, 1, 0.5, 0.25, 0.125. . . .

- a) Design a **recursive** Python function to produce the above output when a user enters an integer from the keyboard.
- b) Use the loop to run the program and display the correct output until user input -1.
- c) Sample Output:

Enter number:1

Output:2

Enter number:2

Output:1

Enter number:3

Output:0.5

Enter number: -1

Output: Finished

**Note: 0 marks for non-recursive solutions**

**Upload your answer using given in the course web link “Paper Number 2”**

## Grading Sheet:

- 1) Program is compiling. **2 marks**
- 2) Program is running successfully. **2 marks**
- 3) Program takes the input number as integer. **2 marks**
- 4) Correct implementation recursive function. **6 marks**
- 5) Display the output correctly **2 marks**
- 6) Use of loop correctly **4 marks**
- 7) Include comments and properly indented. **2 marks**
- 8) Plagiarism testing tool results: .....

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## Paper Number 2 (20 marks)

The Fibonacci sequence is the series of numbers:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34,

The next number is found by adding up the two numbers before it as given by the following mathematical function.

$$F_0 = 0$$

$$F_1 = 1$$

$$F_n = F_{n-1} + F_{n-2}, n > 1$$

A recursive algorithm for the Fibonacci calculation is given below:

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### Algorithm 1: $F(n)$

---

**Input:** Some non-negative integer  $n$

**Output:** The  $n$ th number in the Fibonacci Sequence

**if**  $n \leq 1$  **then**

**return**  $n$

**else**

**return**  $F(n-1) + F(n-2)$ ;

---

- Write a program in Python to read an integer from the keyboard.
- Develop a function in python named as Fibonacci and implement the above recursive algorithm.
- Pass the input number as parameter to the function developed and get the Fibonacci number as output.
- Use the loop to run the program and display the correct output until user inputs -1.

**Upload your answer using given template to the course web link “Paper Number 2”**

### Grading Sheet:

- Program is compiling. **2 marks**
- Program is running successfully. **2 marks**
- Program takes the input number as integer. **2 marks**
- Correct implementation Fibonacci function. **6 marks**

- 5) Correct output **2 marks**
- 6) Use of loop correctly **4 marks**
- 7) Include comments and properly indented. **2 marks**
- 8) Plagiarism testing tool results:.....

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## Paper Number 4 (20 marks)

Consider the following recursive sequence of numbers:

1, 2, 4, 7, 11 . . . .

- a) Design a **recursive** Python function to produce the above output when a user enters an integer from the keyboard.
- b) Use the loop to run the program and display the correct output until user input -1.
- c) Sample Output:

Enter number:1

Output:1

Enter number:2

Output:2

Enter number:3

Output:4

Enter number: -1

Output: Finished

**Note: 0 marks for non-recursive solutions**

**Upload your answer using given in the course web link “Paper Number 4”**

## Grading Sheet:

- 1) Program is compiling. **2 marks**
- 2) Program is running successfully. **2 marks**
- 3) Program takes the input number as integer. **2 marks**
- 4) Correct implementation recursive function. **6 marks**
- 5) Display the output correctly **2 marks**
- 6) Use of loop correctly **4 marks**
- 7) Include comments and properly indented. **2 marks**
- 8) Plagiarism testing tool results: .....

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## Paper Number 4 (20 marks)

The power function can be defined as  $pow(x, n) = x^n$ . This can be evaluated using the multiplication as  $x^n = x \times x^{n-1}$  where  $x$  is any real number and  $n$  is a non-negative integer. [Hint:  $pow(x, n-1) = x^{n-1}$ ]

A recursive algorithm for the power calculation is given below:

**Power**                       $x^N = x * x^{N-1}$  for  $N > 0$   
                                  $x^0 = 1$

```
1 function Power returns a Num(base, exp)
2 // Computes the value of Baseexp
3 // Pre: exp is a non-negative integer
4 if (exp = 0) then
5     returns 1
6 else
7     returns base * Power(base, exp-1)
8 endif
9 endfunction
```

- Write a program in Python to read an integers from the keyboard for  $x$  and  $n$ .
- Develop a function in python named as power and implement the above recursive algorithm.
- Pass the input numbers as parameter to the function developed and get the power of number as output.
- Use the loop to run the program and display the correct output until user inputs -1.

**Upload your answer using given template to the course web link “Paper Number 4”**

## Grading Sheet:

- Program is compiling. **2 marks**
- Program is running successfully. **2 marks**
- Program takes the input number as integer. **2 marks**
- Correct implementation power function. **6 marks**
- Display the output correctly **2 marks**
- Use of loop correctly **4 marks**
- Include comments and properly indented. **2 marks**
- Plagiarism testing tool results:.....





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## Paper Number 6 (20 marks)

Consider the following recursive sequence of numbers:

1, 3, 7, 15, 31 . . . .

- a) Design a **recursive** Python function to produce the above output when a user enters an integer from the keyboard.
- b) Use the loop to run the program and display the correct output until user input -1.
- c) Sample Output:

Enter number:1

Output:1

Enter number:2

Output:3

Enter number:3

Output:7

Enter number: -1

Output: Finished

**Note: 0 marks for non-recursive solutions**

**Upload your answer using given in the course web link “Paper Number 6”**

## Grading Sheet:

- 1) Program is compiling. **2 marks**
- 2) Program is running successfully. **2 marks**
- 3) Program takes the input number as integer. **2 marks**
- 4) Correct implementation recursive function. **6 marks**
- 5) Display the output correctly **2 marks**
- 6) Use of loop correctly **4 marks**
- 7) Include comments and properly indented. **2 marks**
- 8) Plagiarism testing tool results: .....

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## Paper Number 6 (20 marks)

The sum of the  $n$  cubes numbers are given by the following formula:

$$1^3 + 2^3 + 3^3 + \dots + n^3 = \frac{n^2(n+1)^2}{4}$$

A recursive algorithm for the sum of first  $n$  cube calculation is given below:

---

**Algorithm 1** Algorithm  $S(n)$ 

---

```
1: //Input: A positive integer  $n$ 
2: //Output: The sum of the first  $n$  cubes
3: if  $n = 1$  then
4:     return 1
5: else
6:     return  $[S(n - 1) + n * n * n]$ 
```

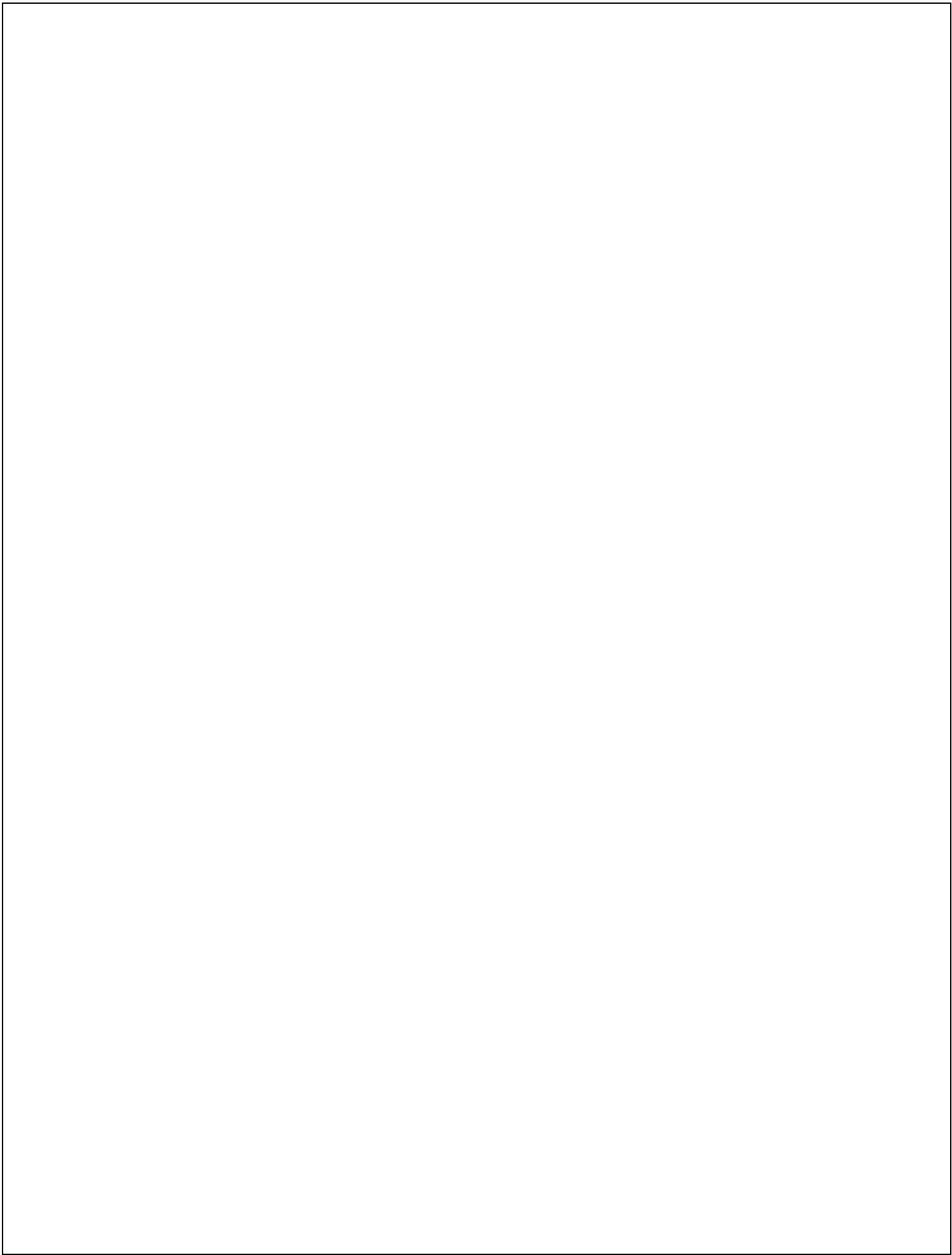
---

- Write a program in Python to read an integer from the keyboard for  $n$ .
- Develop a function in python named as sumcube and implement the above recursive algorithm.
- Pass the input numbers as parameter to the function developed and get the sum of cubes of number as output.
- Use the loop to run the program and display the correct output until user inputs -1

**Upload your answer using given template to the course web link “Paper Number 6”**

### Grading Sheet:

- Program is compiling. **2 marks**
- Program is running successfully. **2 marks**
- Program takes the input number as integer. **2 marks**
- Correct implementation sumcube function. **6 marks**
- Display the output correctly **2 marks**
- Use of loop correctly **4 marks**
- Include comments and properly indented. **2 marks**
- Plagiarism testing tool results:.....



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## Paper Number 8 (20 marks)

The function  $sum(n)$  is defined as the sum of integers from 1 to  $n$ .

$$sum(n) = 1 + 2 + 3 + 4 + \dots + n$$

The recursive relation for  $sum(n)$  where  $n$  is a non-negative integer is given by

$$sum(n) = sum(n-1) + n$$

[Hint:  $sum(n-1) = 1 + 2 + 3 + 4 + \dots + (n-1)$ ]

$$\sum_{i=1}^n i = 1 + 2 + \dots + n$$

The sum of  $n$  is given here:

A recursive algorithm for the sum of sum of  $n$  calculation is given below:

---

### Algorithm 1 Algorithm $S(n)$

---

```
1: //Input: A positive integer  $n$ 
2: //Output: The sum of the first  $n$ 
3: if  $n = 1$  then
4:   return 1
5: else
6:   return [ $S(n-1) + n$  ]
```

---

- Write a program in Python to read an integer from the keyboard for  $n$ .
- Develop a function in python named as sum and implement the above recursive algorithm.
- Pass the input numbers as parameter to the function developed and get the sum of number as output.
- Use the loop to run the program and display the correct output until user inputs -1.

Upload your answer using given template to the course web link “Paper Number 8”

### Grading Sheet:

- Program is compiling. **2 marks**
- Program is running successfully. **2 marks**
- Program takes the input number as integer. **2 marks**
- Correct implementation sum function. **6 marks**
- Display the output correctly **2 marks**

- 6) Use of loop correctly **4 marks**
- 7) Include comments and properly indented. **2 marks**
- 8) Plagiarism testing tool results:.....