UNIT-4 RECURSION

- The function is called recursive function if it calls to itself and recursion is a process by which a function calls itself repeatedly until some specified condition will be satisfied.

- A function will be recursive, if it contains following features:
  - The function should call itself.
  - The function should have stopping condition.

- The concept of using recursive function is to repeat the execution of statements many times is known as recursion.

Note: a recursion use stack for its implementation.

Difference between Recursion and Iteration

Recursion	Iteration
1. Function that contains a call statement to itself.	1. It calls for Repetition of some progress until certain criteria is met.
2. It requires Stack implementation.	2. No use of Stack.
3.Slow process	3. Fast process than recursion.
4. Inefficient memory utilization.	4. Efficient memory utilization.
5. Shorter code, so time efficient.	5. Longer code, consume more time.
6. Example to find factorial of entered number using recursion.	6. Example to find factorial of entered number using iteration.

Disadvantages of Recursion

1. It consumes more storage space because of stack implementation.
2. The computer may run out of memory if the recursion calls are not checked.
3. It is not more efficient in term of speed.

Application

- Game development
- Tree Traversal
- Expression conversion
- Binary search algorithm
- used in sorting and searching algorithm

# Program to find factorial of entered number using recursive function.

```
#include<stdio.h>
#include<conio.h>
long int factorial(int n);
void main()
{
        clrscr();
        int n;
        long int x;
        printf("Please enter the number\n");
        scanf("%d",& n);
        x=factorial(n);
        printf("The factorial of %d is %ld",n,x);
        getch();
}
        long int factorial(int n)
        {
                if(n<=1)
                        return 1;
                else
                        return (n* factorial(n-1));
        }
```

Output

```
Please enter the number: 5
The factorial of 5 is 120
```

//Program to find sum of all natural numbers from 1 to n using recursive function.

```
#include<stdio.h>
#include<conio.h>
int sum (int);
void main()
```

```
{
	int n, s;
	printf("Input a number:");
	scanf("%d",&n);
	s=sum(n);
	printf("\n The sum of natural number from 1to %d is %d",n,s);
	getch();
}

int sum (int n)
{
	if(n<=0)
		return 0;
	else
		return(n+sum(n-1));
}
```

Output

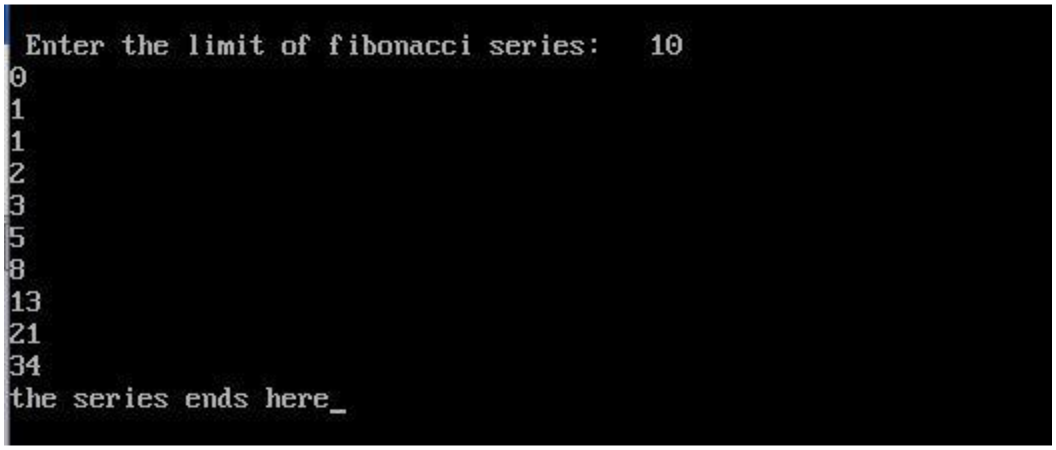
```
Input a number: 10
The sum of natural from 1to 10 is 55
```

//Program to display Fibonacci series up to nth term.

```
#include<conio.h>
#include<stdio.h>
void fseries(int);
void main()
{
	int limit,f0=0,f1=1;
	clrscr();
	printf("\n Enter the limit of fibonacci series:\t");
	scanf("%d",&limit);
	if (limit >2)
	{
		printf("%d\n%d",f0,f1);
		fseries(limit-2);
	}
	else if (limit == 2)
		printf("%d\n%d",f0,f1);
	else if (limit == 1)
		printf("%d",f0);
	else
		printf("series not possible");
	getch();
}

          void fseries (int p)
          {
                    int fib;
                    static int f0=0, f1=1;
                    if (p == 0)
                              printf("\nthe series ends here");
                    else
                    {
                              fib = f0 + f1;
                              f0 = f1;
                              f1 = fib;
                              printf("\n%d",fib);
                              fseries (p-1);
                    }
          }
```

Output:



```
 Enter the limit of fibonacci series:   10
0
1
1
2
3
5
8
13
21
34
the series ends here_
```

The Tower of Hanoi (TOH) and its Solution:

TOH is a famous recursive problem in computer science which is based on three pegs and the set of disk of different size. Each disk has a hole in centre, so that it can be stacked on any peg.

Let A, B, C be the three pegs. At the beginning of the game, the disks are stacked on peg A in such a way that the largest size disk is on the button and smallest sized disk on top.

The problem is to move disk from peg A to peg C, using peg B as auxiliary peg. So, peg A is a source peg & peg C is destination peg.

Rule of Game

1. On transferring the disk from source peg to destination peg at any point, no longer disk can be placed on smaller one.
2. Only one disk can be moved at a time.
3. Each disk must be stacked on only one of pegs.

Example1:

1. Let us take an e.g. where number of disk (n) =2 and show the step by step process.

Note:
Peg A is Source Peg
Peg B is Intermediate Peg
Peg C is Destination Peg

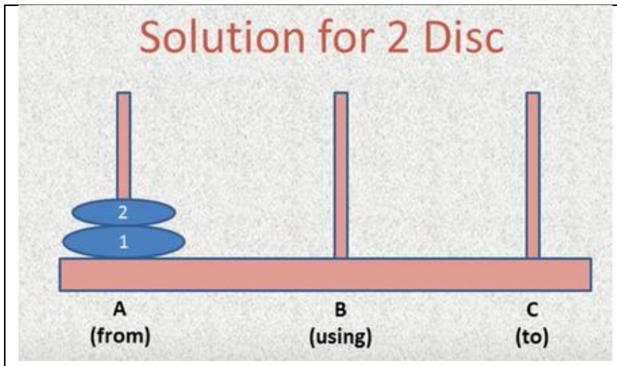


Fig a: Initial condition of disk

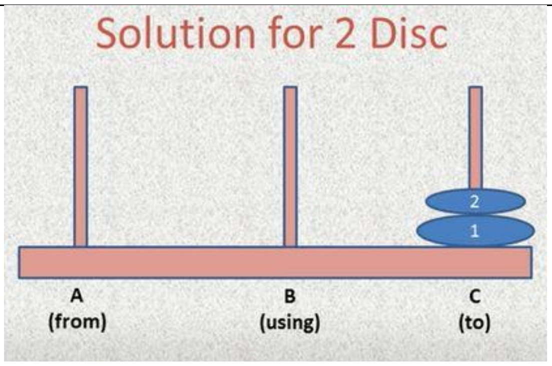


Fig b: Final condition of disk

So the problem is to move disk1 and disk2 from Peg A to Peg C as shown in the Fig b.

Solution:

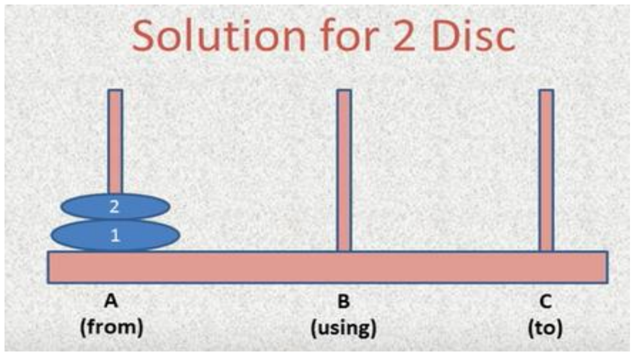
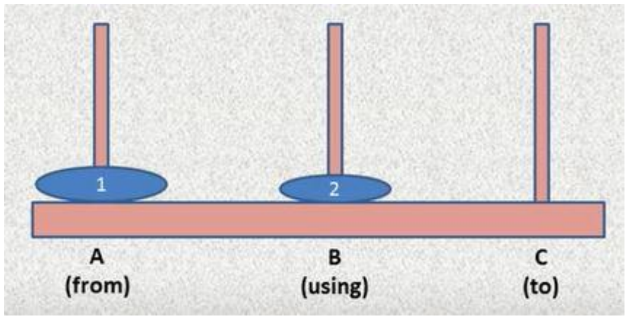
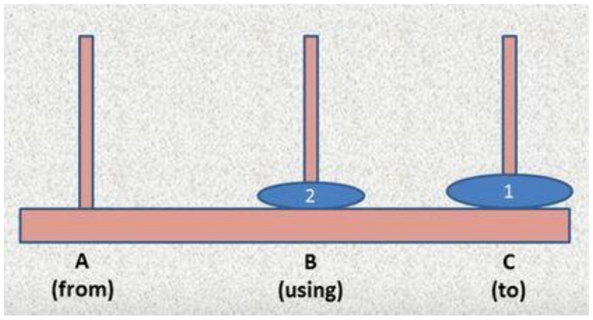


Fig a: Initial condition of disk

Step 1:	**Step 2:**
 **Fig1: Move a disk 2 from A to B**	 **Fig2: Move a disk 1 from A to C**

Step 3:

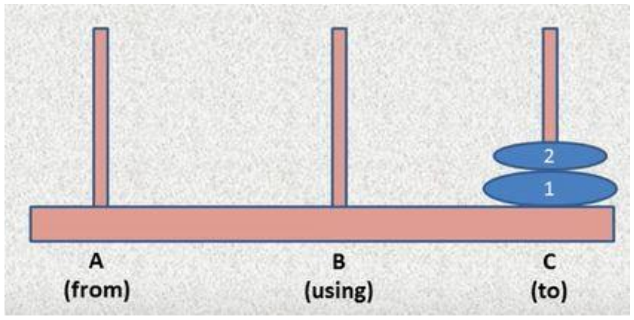


Fig3: Move a disk 2 from B to C

Example2:

2. Let us take an e.g. where number of disk (n) =3 and show the step by step process.

Solution:

Solution for 3 Disc

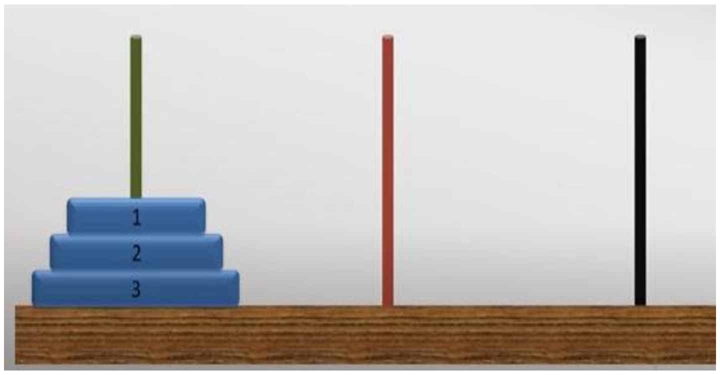
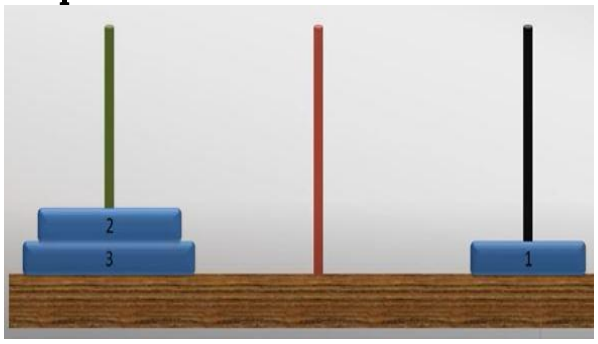


Fig a: Initial condition of disk

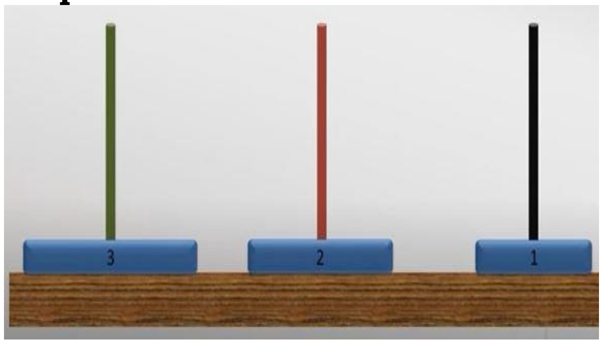
Step 1:



A B C

Fig1: Moving disk 1 from A to C

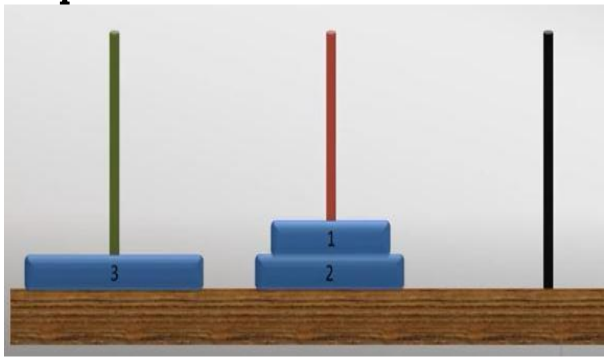
Step 2:



A B C

Fig2: Moving disk 2 from A to B

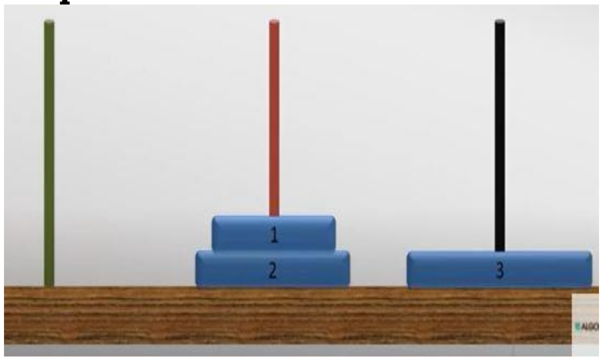
Step 3:



A B C

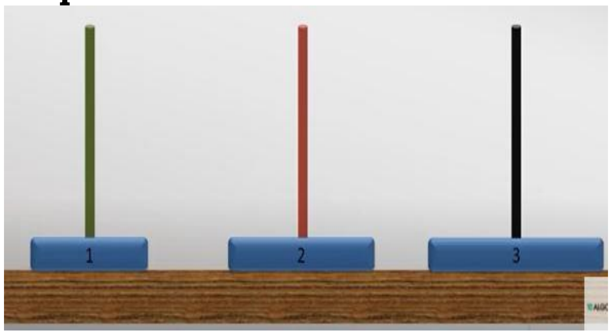
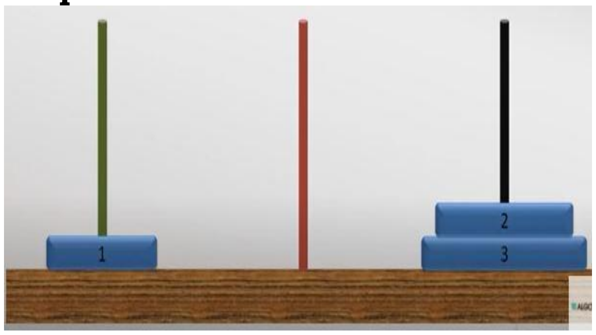
Fig3: Moving disk 1 from C to B

Step 4:

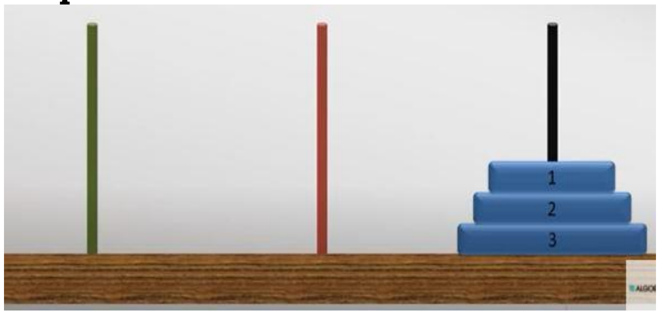


A B C

Fig4: Moving disk 3 from A to C

Step 5:	Step 6:
 A B C Fig5: Moving disk 1 from B to A	 A B C Fig6: Moving disk 2 from B to C

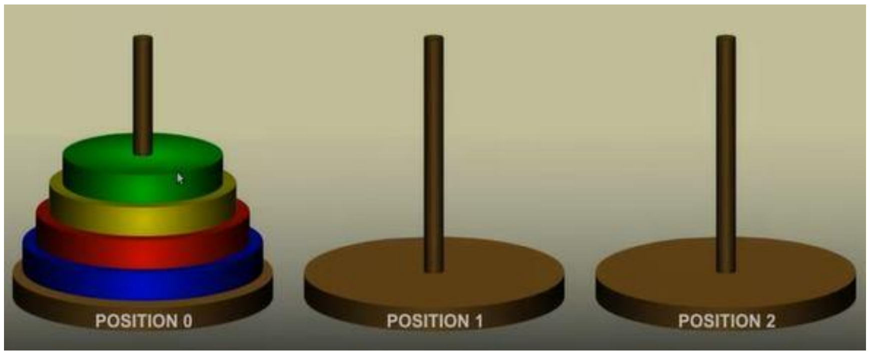
Step 7:

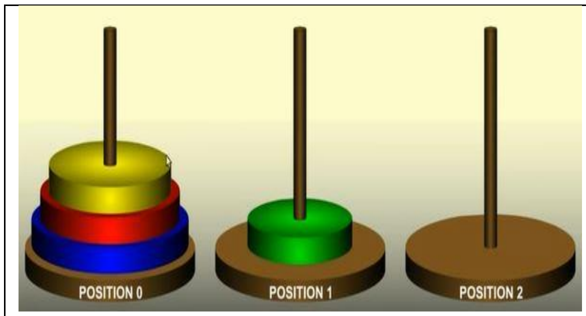
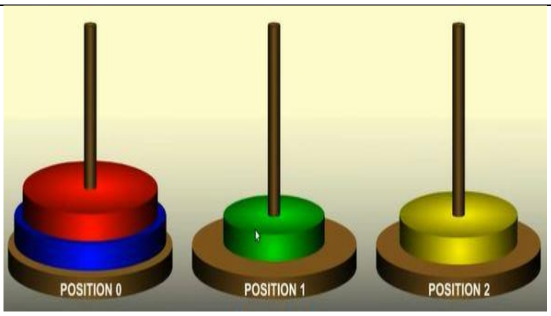
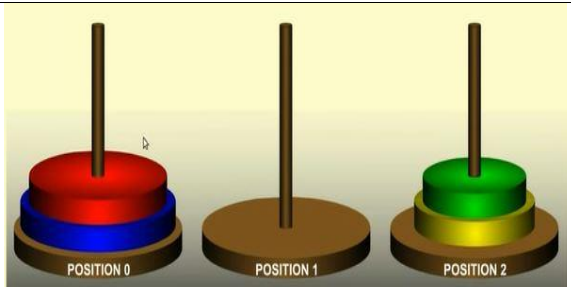
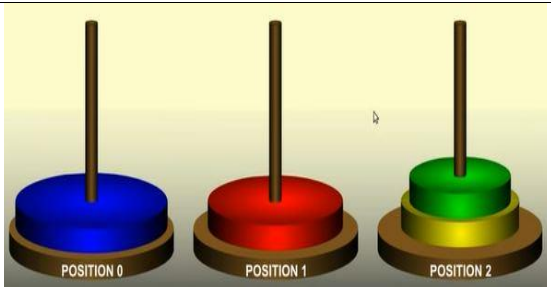
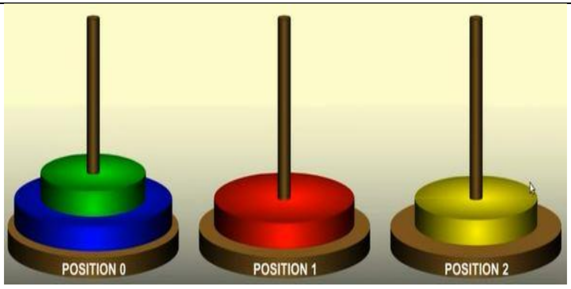
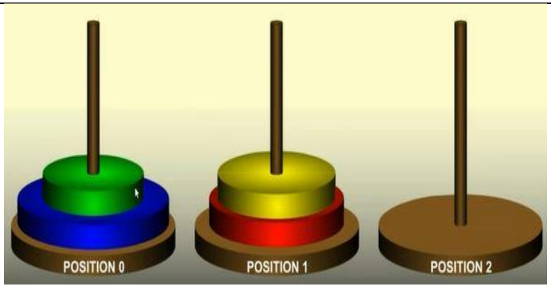


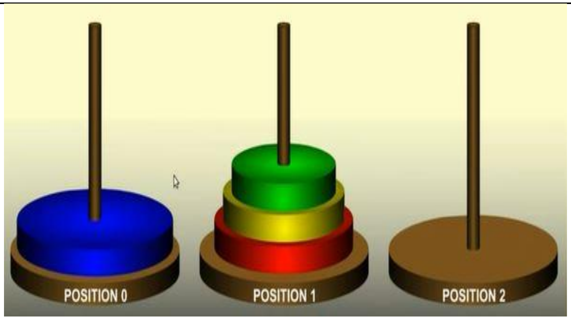
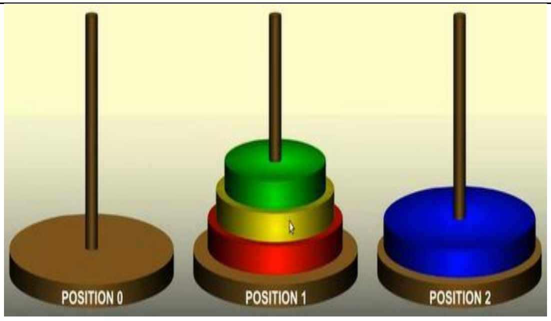
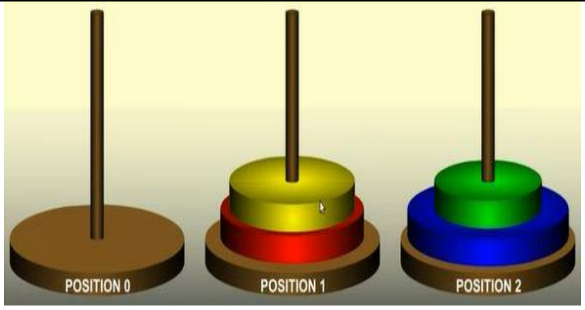
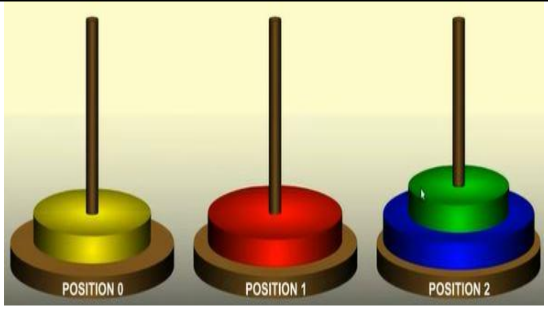
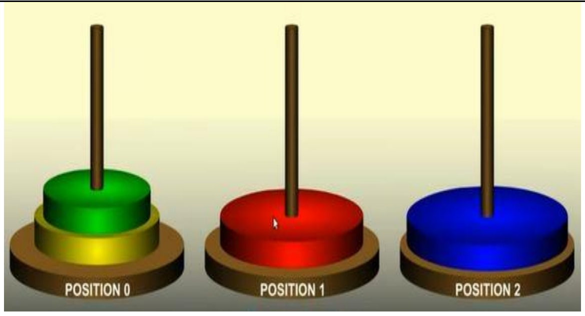
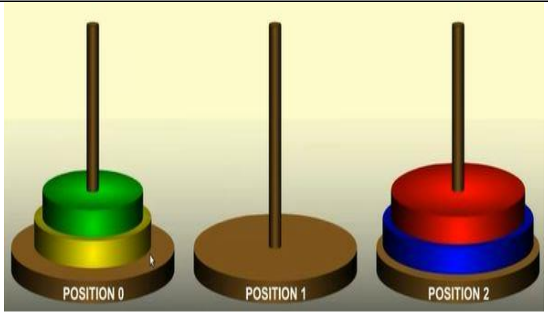
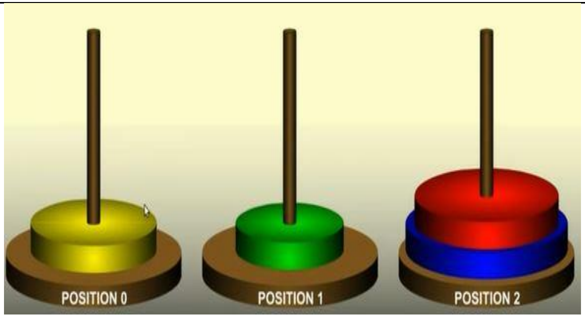
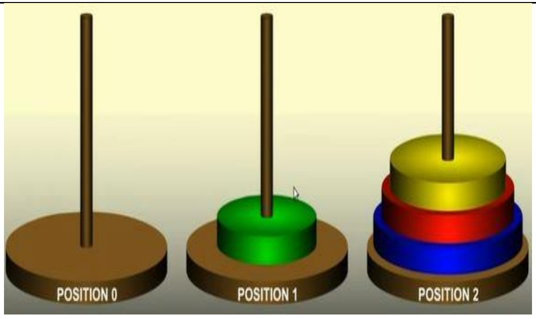
A B C

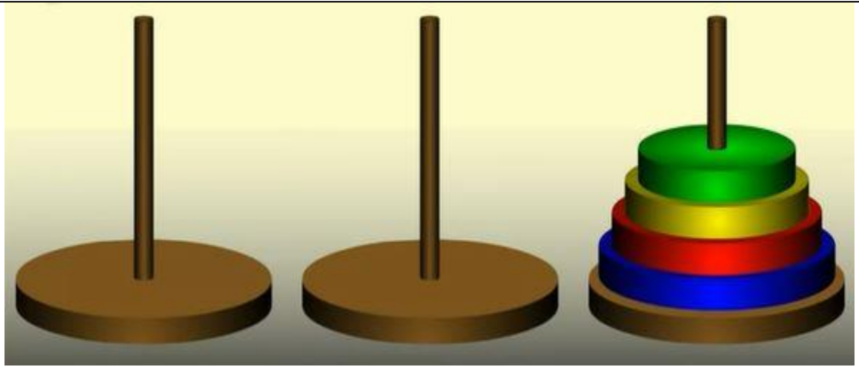
Fig7: Moving disk 1 from A to C

Example 3: for number of disk (n) =4



 **Step:1**	 **Step:2**
 **Step:3**	 **Step:4**
 **Step:5**	 **Step:6**

 **Step:7**	 **Step:8**
 **Step:9**	 **Step:10**
 **Step:11**	 **Step:12**
 **Step:13**	 **Step:14**



Step:15

Program of TOH:

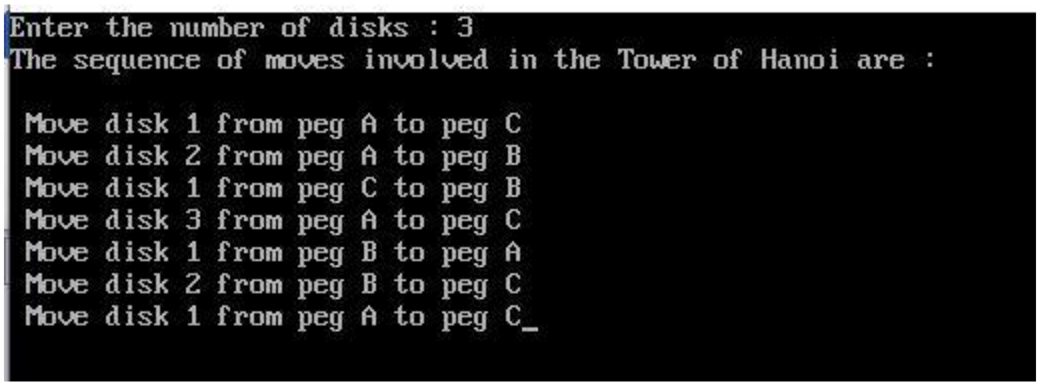
```
// A C program for Tower of Hanoi using Recursion
#include<stdio.h>
#include<conio.h>

void towers(int, char, char, char);

int main()
{
    int num;
    clrscr();

    printf("Enter the number of disks : ");
    scanf("%d", &num);
    printf("The sequence of moves involved in the Tower of Hanoi are :\n");
    towers(num, 'A', 'C', 'B');
    getch();
    return 0;
}
void towers(int num, char frompeg, char topeg, char auxpeg)
{
    if (num == 1)
    {
     printf("\n Move disk 1 from peg %c to peg %c", frompeg, topeg);
     return;
    }
    towers(num - 1, frompeg, auxpeg, topeg);
    printf("\n Move disk %d from peg %c to peg %c", num, frompeg, topeg);
    towers(num - 1, auxpeg, topeg, frompeg);
}
```

Output:



```
Enter the number of disks : 3
The sequence of moves involved in the Tower of Hanoi are :

 Move disk 1 from peg A to peg C
 Move disk 2 from peg A to peg B
 Move disk 1 from peg C to peg B
 Move disk 3 from peg A to peg C
 Move disk 1 from peg B to peg A
 Move disk 2 from peg B to peg C
 Move disk 1 from peg A to peg C_
```

Questions:

1. What is Recursion/Recursive Function? 2 marks
2. WAP to find the factorial of entered number using recursion. 5 marks
3. WAP to print Fibonacci series using recursive function. 5 marks
4. Explain the Tower of Hanoi problem with an example. 8 marks

Note:

- **Do above questions in a note copy.**
- **Make a lab report of TOH problem in a4 paper.**