MCA-1 Programming Lab
Set-5: Miscellaneous C/C++ Coding Assignments

1. Write a program to multiply 2 integers a & b (take input from user).
   Constraint: $1 \leq a, b \leq 10^{1000}$.

   Sample Runtime Environment:

   ```
   Enter a:
   2049874329569346590314032475981765481654981644659031654916541403247598176
   5481654984659031654916541403247598176548165490498743204987432049874328465
   9031654916541403247598176548165498465903165491654140324759817654816549840
   4987432049874326590316654916541403247598176548165498164 (user input)

   Enter b:
   5491654140324759817654816549816454916541403247598176548165498164549165414
   0324759817654816549816446590316549165414032475981765481654984659031654916
   5414032475981765481654904987432049874320498743284659031654916541403247598
   1765481654984659031654916541403247598176548165498404987432049874326590316
   5491654140324759817654816549846590316549165414032475981765481654980498743
   2 (user input)

   Multiplication Result:
   11257200849124943433279170670345590296394826431637982736894156783614047460
   6069555061521996602639841369507753377321390258486884847575965766127193320
   9955053202525647820400414708801983276020521062487451802209996536703195310
   2897905672581374722214270241537451528342328644195340629616583748184183010
   9553987916601419343086276192729083176107434065623277401910202389884620483
   00710540110084113161819115299586866213373807327629104014067572104564200428
   19390546124148789927935018864897890367228383203452775119066448885949800268
   32538335818666222106066306040997994899237987666011526181379195399211680401
   8370032720799941115386857377456084006684714039074848
   ```

   *You can follow your own output formatting but it must be correct and interpretable.

2. Write a program to factorize the polynomial, $ax^3 + bx^2 + cx + d$, where a,b,c & d are integers and to be taken as user input. The constraints are: $-20 \leq a, b, c, d \leq 20$ and $a \neq 0$. Input consists only one line of 4 space separated values a, b, c & d respectively.

   Sample Runtime Environment:

   ```
   Enter the coefficients of the polynomial: 9 0 0 -9 (user input)
   The Polynomial is: 9x^3 - 9 (you can write it as 9x^3 + 0x^2 + 0x^1 - 9x^0)

   No. of factors: 3
   Factor#1: 9
   Factor#2: x-1 (you can write it as 1x^1 - 1x^0)
   Factor#3: x^2 + x + 1 (you can write it as 1x^2 + 1x^1 + 1x^0)
   ```

   *You can follow your own output formatting but it must be correct and interpretable.

3. A traveler has to climb to the top of the hill with the least possible cost. The hill climbing process and the corresponding cost are described below.

   The hill is represented by a 2-D binary matrix of order m×n $(1 \le m, n \le 50)$ in which 1 means the traveler can go to that spot (cell), 0 means the traveler cannot go to the spot. The traveler can directly go to its neighbor spot in the right or left direction with cost 2, upper direction with cost 4, lower direction with cost 1. He cannot move diagonally. Starting from the bottom-left corner, the traveler has to reach the maximum reachable height with the least possible cost.

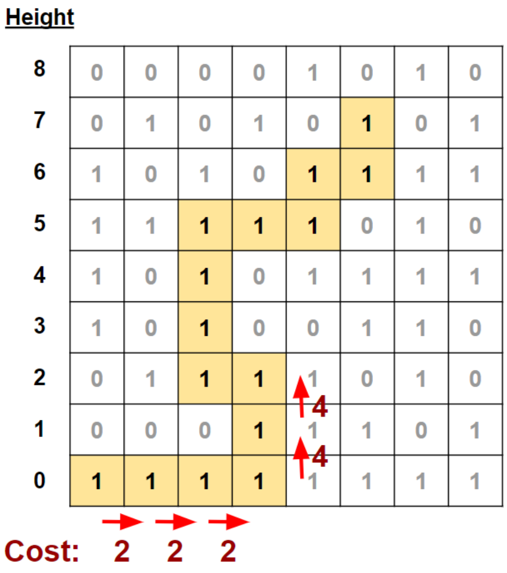
   Print the maximum reachable height of the hill and the least possible cost to reach there.

   Sample Runtime Environment:

```
Enter the dimension of the hill matrix: 9 8 (i.e. m=9 & n=8)
Enter the hill matrix:
0 0 0 0 1 0 1 0
0 1 0 1 0 1 0 1
1 0 1 0 1 1 1 1
1 1 1 1 1 0 1 0
1 0 1 0 1 1 1 1
1 0 1 0 0 1 1 0
0 1 1 1 1 0 1 0
0 0 0 1 1 1 0 1
1 1 1 1 1 1 1 1 (user input up to this)

Maximum reachable height: 7
Minimum cost to reach the maximum reachable height: 42
```

   Explanation:



Height								
8	0	0	0	0	1	0	1	0
7	0	1	0	1	0	1	0	1
6	1	0	1	0	1	1	1	1
5	1	1	1	1	1	0	1	0
4	1	0	1	0	1	1	1	1
3	1	0	1	0	0	1	1	0
2	0	1	1	1	1	0	1	0
1	0	0	0	1	1	1	0	1
0	1	1	1	1	1	1	1	1

The figure in the left explains everything. The cost of the first 5 moves of the traveller is written. Calculate the other costs according to the moves & sum it up to get the total cost.

Note: There can be other ways to get to the maximum reachable height. Print the least cost to reach there.

4. Find the number of binary strings of length n, such that ‘0’ must be a neighbor of ‘1’ and ‘1’ must be a neighbor of ‘0’. Take n ($2 \leq n \leq 1000$) as user input. Print the answer in ‘modulo $10^9 + 7$’ format.

   For example, for string length n=5, ‘01101’ will be counted but ‘10001’ won’t be counted as the middle ‘0’ is NOT satisfying the condition.

5. Print factored polynomial form of $f(k)$ where, $f(k) = 1^k + 2^k + 3^k + \ldots + n^k$, the value of the integer k $(1 \leq k \leq 20)$ is to be taken as user input.

Test Case	Input **k**	Output **f(k)**
1	1	n*(n+1)/2
2	3	n*n*(n+1)*(n+1)/4
3	6	n*(n+1)*(2n+1)*(3n^4 + 6n^3 - 3n + 1)/42

Sample Runtime Environment:

```
Enter k: 2
f(k) is: n(n+1)(2n+1)/6
```

*You can follow your own output formatting but it must be correct and interpretable.

Hint: Initially you have to find the simple polynomial form of $f(k)$. Then you need to factorize it as you did in the 2nd assignment (But this factorization will be a generic version of what you did in the 2nd assignment for degree 3 only).