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: $1 \leq a, b \leq 10^{1000}$. **[5 marks]**

   Sample Runtime Environment:
   Enter a:
   20498743295693465903140324759817654816549816446590316549165414032475981765
   54816549846590316549165414032475981765481654904987432049874320498743284659
   03165491654140324759817654816549846590316549165414032475981765481654984049
   49874320498743265903166549165414032475981765481654981649 (user input)

   Enter b:
   54916541403247598176548165498164549165414032475981765481654981645491654140
   32475981765481654981644659031654916541403247598176548165498465903165491654
   14032475981765481654904987432049874320498743284659031654916541403247598176
   54816549846590316549165414032475981765481654980498743204987432659031654916
   54140324759817654816549846590316549165414032475981765481654980498743
   2 (user input)

   Multiplication Result:
   11257200849124943433279170670345590296394826431637982736894156783614047460
   60695550615219966026398413695077533773213902584868848475759657661271933209
   95550532025256478204004147088019832760205210624874518022099653670319531 0
   28979056725813747222142702415374515283423286441953406296165837481841830109
   55398791660141934308627619272908317610743406562327740191020238988462048 3
   00710540110084113161819115299586866213373807327629104014067572104564200428
   19390546124148789927935018864897890367228383203452775119066448885949800268
   32538335818666222106066306040997994899237987666011526181379195399211680401
   837003272079994111538685737745608400668471403907484 8

   *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. The polynomial can be factorized when all the coefficients in all of its factors will be integers, otherwise print the polynomial itself. **[20 marks]**

   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.

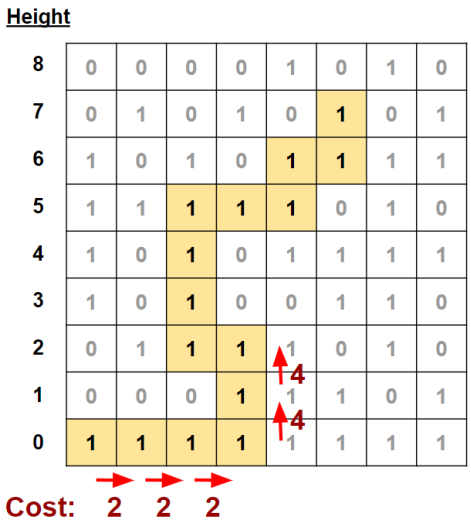
   The hill is represented by a 2-D binary matrix of order m×n ($1 \leq m, n \leq 50$) in which 1 means the traveler can go to that spot (cell), 0 means the traveler cannot go to the spot. The traveler can directly go to its neighbor spot in the right or left direction with cost 2, upper direction with 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. **[10 marks]**

   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:



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. **[15 marks]**

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. **[50 marks]**

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).