

2148 - I2P(II) 2020\_Chen\_mid1\_practiceScoreboard

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Clarification							
#	Problem	Asker	Description	Reply	Replier	Reply Time	For all team

OverviewProblem

12254 - Thanos' DilemmaStatusLimitsSubmit

Description

In "Avengers 3", we know that Thanos wants to eliminate half of the world to keep the world in a good balance. But, have you ever wondered about how he choose "1/2" ? Why don't he choose "1/3", "1/4", or "253/502" ?

He knows that the population of this world would just keep growing, so he calculated the formula of population of this world:

On the  $i$ -th year from the start of the world, the population of this world  $P(i)$  would be:  $P(i-1) + 2 * P(i-2) + P(i-3)$ .

From this formula, he concluded that  $P(1)=1, P(2)=12, P(3)=13$ .

According to this formula, he could estimate the populations of the world on every year, so that he could choose the percentage of the population he would like to eliminate. (We don't know how he choose)

Because Thanos has a lot of planets to conquer, he asks you to calculate  $P(x)$ , while  $x$  is given by him.

The world has lived for so many years, so he might ask you  $P(x)$  where  $x$  would be very large. And in case of  $P(x)$  is super large, the number should mod  $10^9+7$ .



"Thanos Thinking About This Problem"

If you click on this picture, something might happen...

- Given  $t$ , indicates the number of testcases.
- $P(i) = P(i-1) + 2 * P(i-2) + P(i-3)$
- $P(1)=1, P(2)=12, P(3)=13$
- Given  $x$ , you are going to calculate  $P(x) \% (10^9+7)$  of every testcase.

Hint: use fpw(快速幂) to solve this problem!

If we rewrite the equation into matrix form, we could get the following formula:

$$\begin{pmatrix} P(i) \\ P(i-1) \\ P(i-2) \end{pmatrix} = \begin{pmatrix} 1 & 2 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} P(i-1) \\ P(i-2) \\ P(i-3) \end{pmatrix}, \quad i > 3$$

With this formula, we can do something more:

$$\begin{pmatrix} P(n) \\ P(n-1) \\ P(n-2) \end{pmatrix} = \begin{pmatrix} 1 & 2 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}^{n-3} \begin{pmatrix} P(3) \\ P(2) \\ P(1) \end{pmatrix}, \quad n > 3$$

Now, we can implement fpw(快速幂) method on the matrix power part. For those  $n \leq 3$ , just output the answer.

Note that you are encouraged to implement a "matrix" struct to solve this easier.

Input

The first line contains one integer  $t$ , indicates the number of testcases.

There are  $t$  lines below, each line contains one integer  $x$ .

$1 \leq t \leq 20, 1 \leq x \leq 10^{18}$ .

Output

For each testcase, output exactly one integer  $P(x) \% (10^9+7)$ .

Remember to output a '\n' at the end of every testcase.

Sample InputDownload

```
5
2
3
10
15
30
```

Sample OutputDownload

```
12
13
3513
160609
345389283
```

Discuss