FUNCKIT

PROBLEM STATEMENT

ROUND-1

"Alchemy: the **science of understanding**, deconstructing, and reconstructing matter. However, it is not an all-powerful art. It is impossible to create something out of nothing. If one wishes to obtain something, something of equal value must be given."

- Inspired from the *Manga Series- Fullmetal Alchemist: Brotherhood.*

Homunculus is an artificial human being created using Alchemy. One of such Homunculus is **Envy.** Envy is capable of transforming his outwards appearance to that of any other human being existing. Apart from this enthralling Supernatural Power, Envy is an **Eater of Souls** and has a **Regenerating Power**. The more souls Envy eats, the more powerful he becomes.

A fierce battle is currently raging between Envy and the State Alchemists: **Edward Elric** and **Roy Mustang** at the **5th Laboratory** in **the Central**. Edward Elric is an extremely talented 15 year old State

Alchemist in the country of Amestris. He is popularly known as the **Fullmetal Alchemist**- due to his excellent skills of using his Automail. Roy Mustang is an officer in the Amestrian State Military and is extremely capable of becoming the next Fuhrer- leader of the Amestris. He is popularly known as the **Flame Alchemist** because of his supremacy in creating fire from Alchemy.

Both the State Alchemists have figured out Envy's weakness- **If Envy has only one soul left in his body** which is his own (obviously), **he can be easily killed**. Therefore, they have decided that Fullmetal would attack and kill the souls inside Envy with his Alchemy. When there is only one soul left- the Flame Alchemist would burn Envy. But Envy's special power of regeneration is a challenge for them.

Every second Envy regenerates one lost soul and **every second Fullmetal's Alchemy can kill half of the current number of Souls** inside Envy- yeah Fullmetal's Alchemy is that strong! However, there are few restrictions to both Envy and Fullmetal powers:

1. *If the **number of souls** inside Envy are **odd**, only then **Envy's Regeneration Power works!***
2. *If the **number of souls** inside Envy are **even**, only then **Fullmetal's Alchemy works!***

Roy Mustang knows the **initial number** of souls inside Envy i.e. **n**. He is waiting for his turn to burn Envy when only a single soul is left inside him. He has to use his alchemy immediately before Envy can regenerate as 1 is an Odd Number :(Hence he needs to be prepared and fire immediately when only one soul is left. Roy Mustang is not good at Arithmetic- hence you need to **create a Digital Circuit with minimum cost for him which can predict the minimal time and submit the abstract explaining your approach in detail when he can use his Alchemy to kill Envy**. You will be using LOOPs, Conditions, Arithmetic operations etc. so you have to describe how you are implementing them. **Remember, the battle starts at 0th second.**

In return, you may get to know more about his Flame Alchemy :P.

Constraints:

$0 < n < 15$

Hardware Weightage < 60

Test cases:

n=13

13 ---> 14 ---> 7 ---> 8 ---> 4 ---> 2 ---> 1

Ans: 6.

Deadline: 11/04/2021 11:59 PM

ROUND-2

"On that day, mankind received a grim reminder. We lived in fear of the Titans and were disgraced to live in these cages we called Walls."

- Inspired from the *Manga Series- Attack on Titan*

The Titans haven't been seen over the past 100 years. However, it's the year 845, when two titans namely the **Colossal Titan** and the **Armoured Titan** have appeared. Currently disclosable information: Titans are abnormal Humanoid Giants who are a threat to the Human Race. The chaos and destruction caused by the Armoured Titan is on an unprecedented scale within Wall Maria. Many families have lost their loved ones. **Eren Yeager**- the hero of our story has lost his mother and has sworn to join the **Survey Corps** (A Military Group responsible for hunting down Titans) to put an end to all the Titans.

Five years have passed. Eren has undergone severe training and has finally become a member of one of the Elite Squads of the Survey Corps: the **Levi Squad** under the leadership of **Captain Levi**. Eren, under the Levi Squad has fought many battles against the Titans. During one of the fights, he discovers that he has the Titan powers. **Now he can transform into a Titan**- sounds cool, right?

However, our Captain Levi along with Eren's friends- **Mikasa Ackerman** and **Armin Arlert** have come out with a rather interesting way to use Eren's Titan Powers. Going through the past of the Armoured Titan, Levi has found his weakness- The Armoured Titan can only be defeated by a Titan having the same strength as his and of **exactly the same height** as the Armoured Titan in a Hand-to-Hand Combat.

Eren's Titan has more strength than the Armoured Titan but its height **isn't the exact same** as that of the Armoured Titan. But Eren makes up a plan to change his height. **His Titan Powers allow him to make his height twice as the current height and he can use this power as many times he wants. He also knows that if the Armoured Titan attacks him, then his height is going to be reduced by one unit in each attack. Since Eren's Titan is stronger than that of the Armoured Titan, it is completely up to him whether or not to get injured by an attack.** Discovering all these interesting facts about himself and the Armoured Titan, Eren has decided to have a Hand-to-Hand Combat with the Armoured Titan.

The battle begins at 0th second. In each second, Eren's height can be doubled if he isn't injured by the attack of the Armoured Titan or can be reduced by a unit if he is injured by the attack. Eren wishes to find out the **minimal time in which he would be able to have exactly the same height as that of the Armoured Titan** so that he could defeat him.

Since he isn't good enough in solving such complex mathematical problems, he seeks your help. **Simulate a Digital Circuit on proteus with minimal cost** for him to solve such complex problems. In return, you may get to know more about his Titan Powers :P

Constraints:

0 < Eren's Height (m) < 16

0 < Armoured Titan's Height (n) < 15

Hardware Weightage < 80

Test cases:

1. n = 10, m = 10
   Ans: 0.
2. n = 7, m = 12
   12 ---> 11 ---> 10 ---> 9 ---> 8 ---> 7

   Ans: 5.

3. n = 6, m = 4

4 ---> 3 ---> 6

Ans: 2.

Deadline: 17/04/2021 12:00 PM

Note:

- Weightage of round 1 and round 2 is 30% and 70% respectively.
- There will be extra points for creativity.
- Try to minimize clock cycles and hardware requirements.

The participants are advised to make use of the following ICs for uniformity:

- COMPARATOR:
  - 8 bit identity comparator - 74LS688
  - 4 bit magnitude comparator - 74HC85

- BUFFER:
  - Quadruple buffer gate with tri-state outputs - 74HC125
  - Octal buffer with tri-state outputs - 74HC241

- FLIP FLOPS:
  - Dual Positive Edge Triggered D-Type Flip-flops - 74LS74
  - Quadruple D type Positive Triggered Flip-flops with clear - 74LS175
  - Octal D type Positive Triggered Flip-flops with clear - 74LS273
  - Dual J-K Positive Edge Triggered Flip-flops with clear and preset - 74LS109

- MULTIPLEXER:
  - Quadruple 1 of 2 data selectors/ Multiplexer - 74LS157

❖ COUNTERS:

- ➢ Synchronous 4-bit binary Counters - 74LS161
- ➢ 8 bit binary Counter with tristate output registers - 74LS590
- ➢ 4 bit synchronous up/down Binary Counters - 74LS169

❖ ADDER:

- ➢ 4 bit Binary Full adders with fast carry - 74LS283

❖ MULTIPLIER:

- ➢ 4 bit multiplier with open collector outputs - 74284, 74285

❖ REGISTER:

- ➢ 4 bit Shift Register - 74179
- ➢ 4 bit bidirectional Universal Shift Registers - 74194

GATES:(74 Series)

Weightage of various Components :

- Gates with 1 or 2 inputs - 1
- Gates with 3 or 4 inputs - 2
- Gates with more than 4 inputs - 3
- 4-bit comparator - 11
- Buffer - 3
- Single Flip-flop -1
- Register(4-bit) - 4
- Register(8-bit) - 8
- MUX - 8
- 4/8 bit counter - 6
- Multiplier(4 bit) - 6
- Multiplier(8 bit) - 10
- Adder (4 bit) - 4
- Adder (8 bit) - 8

For any other component not mentioned above, the cost will be assigned on the spot.

Rules :

1. Use only the above mentioned ICs.
2. Submission of round 2 will be considered ,only if you complete the round 1.
3. After the deadline, No submission will be considered.
4. Completion of 1st round is mandatory for participation certificate. Top 3 teams will be eligible for certification of merit.