بسم الله الرحمن الرحيم

1- load.

R M

1 0 3 2

load $R_0 \leftarrow M[32]$

2- load Value

R

2 1 6A

load $R_1 \leftarrow 6A$

3- store.

R M

3 2 1F

store $R_2 \rightarrow M[1F]$

4- MOVE

4 0 1 2

MOVE $R_1 \rightarrow R_2$

$R_1$ [10]

$R_2$ [10]

5 ADD.

5 2 1 0
R R R R

ADD R2 ← R1 + R0

6 → X

7, 8, 9 → A, →

1 ⇒ Jump.

B 3 2 1
R M

Jump to M[21]
if R3 = [R0]

B 2 3F

Jump to M[3F] if $R_2 = R$

Conditional Jump.

if $R_2 \equiv R_0$

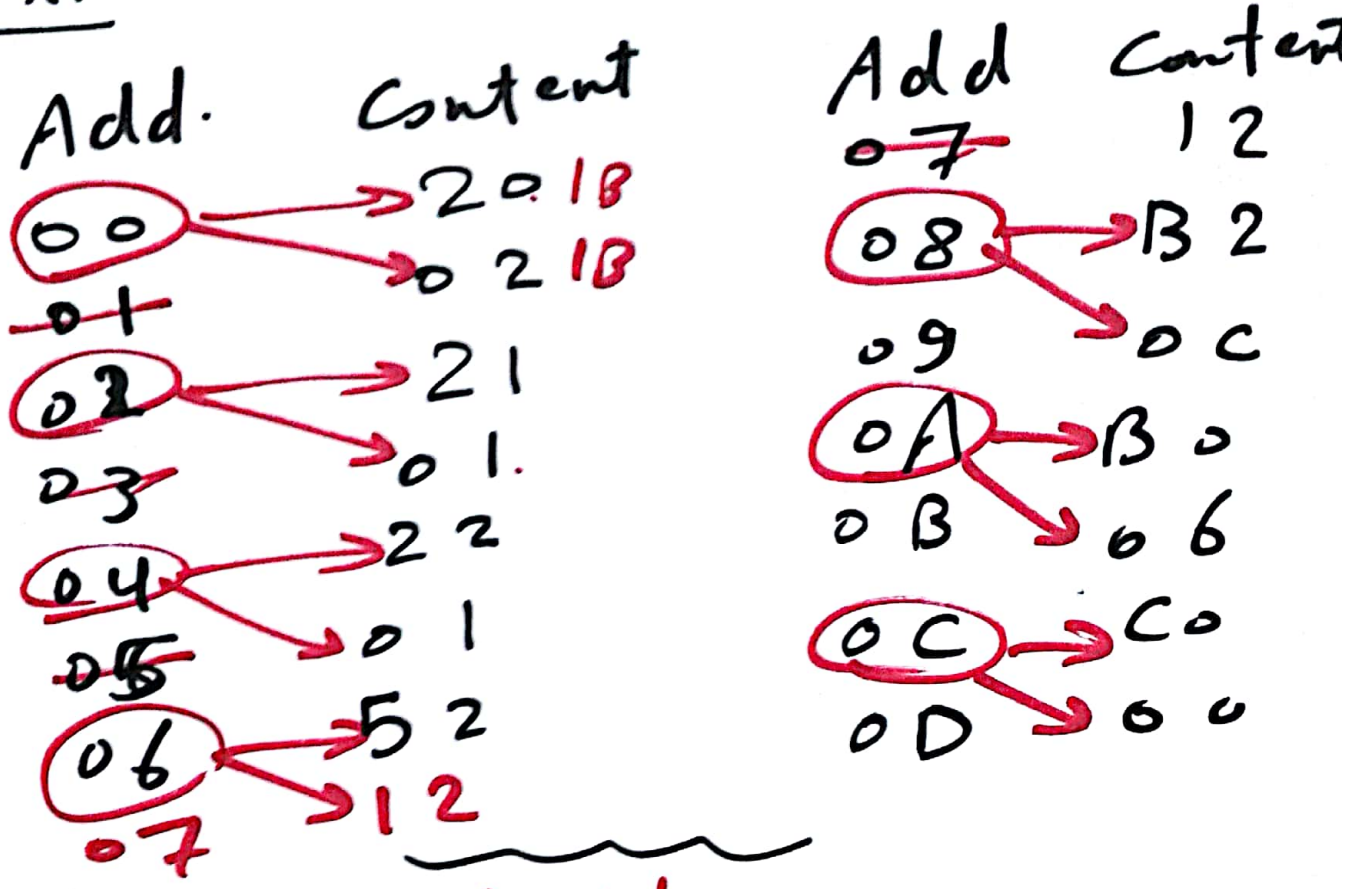
B 0 A1

Jump to M[A1] if

$R_0 = R_0$

unconditional Jump.

EX:




* Instraction table

| Start Add | inst. | Description |
|---|---|---|
| 00 | 20 02 | load R0 ← 02 |
| 02 | 21 01 | load R1 ← 01 |
| 04 | 22 01 | load R2 ← 01 |
| 06 | 52 12 | Add R2 ← R1 + R2 |
| 08 | B2 0C | Jump to M[0C] if R2=R |
| 0A | B0 06 | Jump to M[06] |
| 0C | C0 00 | Halt |

| $R_0$ | $R_1$ | $R_2$ |
|---|---|---|
| 02 | 01 | ~~01~~ 02 |

**IFace Table**

| St. | IFace |
|---|---|
| 00 | $R_0 = 02$ |
| 02 | $R_1 = 01$ |
| 04 | $R_2 = 01$ |
| 06 | $R_2 = R_1 + R_2 = 02$ |
| 08 | if $R_2 = R_0$ ✓ |
| 0C | Halt. |

a) What a bit pattern will be in $R_2$?

$R_2 = (02)_{16}$
$= 0000\ 0010$

b) How many times will the instruction at address 06 be executed?

one time

(5)

Ex:
* Suppose the memory cells at address A4 to B1 Contains the following Program:

| Add. | Content |
|---|---|
| ~~0A~~ | |
| A4 | 20 |
| A5 | 00 |
| A6 | 21 |
| A7 | 03 |
| A8 | 22 |
| A9 | 01 |
| AA | B1 |
| AB | B0 |

| Add. | Content |
|---|---|
| AC | 50 |
| AD | 02 |
| AE | B0 |
| AF | AA |
| B0 | C0 |
| B1 | 00 |

## *Instruction Table

| St. | Instruction | Description |
|---|---|---|
| A4 | 2000 | load $R_0 \leftarrow 00$ |
| A6 | 2103 | load $R_1 \leftarrow 03$ |
| A8 | 2201 | load $R_2 \leftarrow 01$ |
| AA | B1 $B_0$ (M) | Jump to M[$B_0$] if $R_1 \neq R_2$ |
| AC | 5002 | Add $R_0 = R_0 + R_2$ |
| AE | B0 AA (M) | unconditional Jump. |
| B0 | C000 | Halt / Stop. |

## * TFace Table

| $R_0$ | $R_1$ | $R_2$ |
|---|---|---|
| ~~00~~ ~~01~~ ~~02~~ 03 | 03 | 01 |

| St. | TFace |
|---|---|
| A4 | $R_0 = 00$ |
| A6 | $R_1 = 03$ |
| A8 | $R_2 = 01$ |
| AA ① | if $R_1^{03} = R_0^{00}$ X |
| AC | $R_0 = R_0^{00} + R_2^{01} = 01$ |
| AE | ↙ Jump to M[AA] |
| AA ② | if $R_1^{03} = R_0^{01}$ X |
| AC | $R_0 = R_0^{01} + R_2^{01} = 02$ |
| AE | ↙ Jump to M[AA] |
| AA ③ | if $R_1^{03} = R_0^{02}$ X |
| AC | $R_0 = R_0^{02} + R_2^{01} = 03$ |
| AE | ↙ Jump to M[AA] |
| AA ④ | if $R_1^{03} = R_0^{03}$ ↙ Jump to M[B0] |
| B0 | Stop |

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⇒ Assuming the program execution starts address A4 answer the following Questions?

a) What is the Content of $R_0$ after the first time the instruction at address AA is executed.? $R_0 = 00$

b) What is the content of $R_0$ after the second execution of the instruction at address AA? $R_0 = 01$

c) How many times the isstructia at address AA is executed before the machine halts?

Four times.

→ Suppose the memory cell at address E4 to F3 Contain the following Program:.

| Add. | Content |
|---|---|
| E4 | 20 |
| E5 | 00 |
| E6 | 21 |
| E7 | 04 |
| E8 | 22 |
| E9 | 01 |
| EA | B1 |
| EB | F2 |
| EC | 50 |
| ED | 02 |

| Add. | Conte |
|---|---|
| ED | 02 |
| EE | 53 |
| EF | 01 |
| F0 | B0 |
| F1 | EA |
| F2 | C0 |
| F3 | 00 |

# Instruction Table

| St. | inst. | Description. |
|---|---|---|
| E4 | 2000 | load $R_0 \leftarrow 00$ |
| E6 | 2104 | load $R_1 \leftarrow 04$ |
| E8 | 2201 | load $R_2 \leftarrow 01$ |
| EA | B1 F2 | Jump to M[F2] if $R_1 \neq 0$ |
| EC | 5002 | Add $R_0 \leftarrow R_0 + R_2$ |
| EE | 5301 | Add $R_3 \leftarrow R_0 + R_1$ |
| F0 | B0 EA | unconditional Jump ✓ |
| F2 | C000 | halt / stop. |

## Trace Table

| St. | Trace. |
|---|---|
| E4 | $R_0 = 00$ |
| E6 | $R_1 = 04$ |
| E3 | $R_2 = 01$ |
| EA | if $R_1 = R_0$ X |
| EC | $R_0 = R_0 + R_2 = 01$ |
| EE | $R_3 = R_0 + R_1 = 05$ |
| F0 | ↙ |
| EA | if $R_1 = R_0$ X |
| EC | $R_0 = R_0 + R_2 = 02$ |
| EE | $R_3 = R_0 + R_1 = 06$ |
| F0 | ↙ |
| EA | if $R_1 = R_0$ X |
| EC | $R_0 = R_0 + R_2 = 03$ |
| EE | $R_3 = R_0 + R_1 = 07$ |
| F0 | ↙ |
| EA | if $R_1 = R_0$ X |
| EC | $R_0 = R_0 + R_2 = 04$ |
| EE | $R_3 = R_0 + R_1 = 08$ |
| EA | if $R_0 = R_0$ ↙ |
| | F2 → Halt / Stop. |

| $R_0$ | $R_1$ | $R_2$ | $R_3$ |
|---|---|---|---|
| ~~00~~ | 04 | 01 | ~~05~~ |
| ~~01~~ | | | ~~06~~ |
| ~~02~~ | | | ~~07~~ |
| ~~03~~ | | | 08 |
| 04 | | | |

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⇒

| Add | Content |
|---|---|
| 00 | B0 |
| 01 | 03 |
| 02 | 25 |
| 03 | B0 |
| 04 | 0C |
| 05 | 00 |
| 06 | 00 |

| Add | Content |
|---|---|
| 07 | C0 |
| 08 | 00 |
| 09 | 23 |
| 0A | B0 |
| 0B | 03 |
| 0C | B0 |
| 0D | 07 |

⇒ How many instructions will be executed after the machine halts?

four instructions.

⇒ What abit Pattern will be in the Program Counter when the machine halts?

09

a) What is the content of $R_0$ after the first time the inst. at EA is executed?

$R_0 = 300$

b) What is the content of $R_0$ after the second time the inst. at EA is executed?

$R_0 = 01$

c) How many times the inst. at address EA is executed before the machine halts.?

5 times.

d) What is the final value of $R_3$ after the machine halts?

$R_3 = 08$.

## instruction Table

| st. | inst. | Meaning |
|---|---|---|
| 00 | B003 | unconditional Jump Jump to M[03] |
| 03 | B00C | Jump to M[0C] |
| 0C | B007 | Jump to M[07] |
| 07 | C000 | halt /Stop. |

# *logical operations:

## AND , OR , XOR

## AND → ضرب

AND
0 0 → 0
0 1 → 0
1 0 → 0
1 1 → 1

## OR

OR
0 0 → 0
0 1 → 1
1 0 → 1
1 1 → 1

## XOR

0 0 → 0
1 1 → 0
0 1 → 1
1 0 → 1

0 = متشابه
1 = مختلف

EX

AND

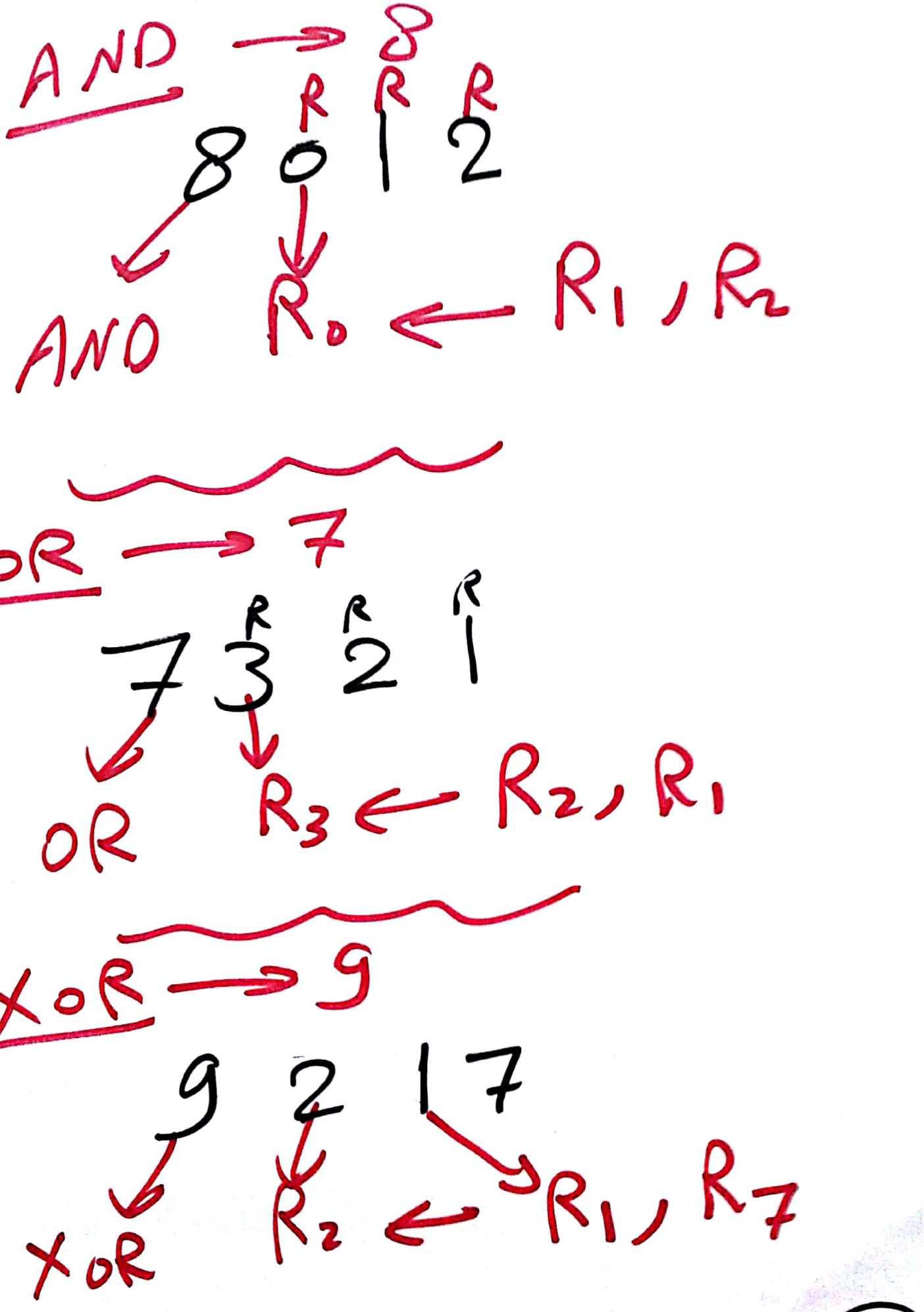
| | | 0 | 0 | 0 | | |
|---|---|---|---|---|---|---|
| | | 0 | | | 0 | |
| | | 0 | 0 | 0 | 0 | 1 |

OR

| | | 0 | | | 0 | |
|---|---|---|---|---|---|---|
| | | 0 | | | 0 | |
| | | 0 | | | | |

XOR

| | | 0 | | 0 | | |
|---|---|---|---|---|---|---|
| | | 0 | | | 0 | |
| 0 | 0 | 0 | 0 | | | 0 |



Given ⇒

B7

| | | |
|---|---|---|
| ① | 10A6 | load $R_0 \leftarrow M[A6]$ |
| ② | 21E7 | load $R_1 \leftarrow E7$ |
| ③ | 8201 | AND $R_2 \leftarrow R_0, R_1$ |
| ④ | 2142 | load $R_1 \leftarrow 42$ |
| ⑤ | 7321 | OR $R_3 \leftarrow R_2, R_1$ |
| ⑥ | 2181 | load $R_1 \leftarrow 81$ |
| ⑦ | 9031 | XOR $R_0 \leftarrow R_3, R_1$ |
| ⑧ | 30A6 | Store $R_0 \rightarrow M[A6]$ |
| ⑨ | C000 | halt / stop. |

$M[A6] = 66$

⇒ if the contents of memory cell $M[A6] = B7$

→ write the content of $M[A6]$ at the end of the execution.

# TFace Table

| St | TFace. |
|---|---|
| ① | $R_0 = B7$ |
| ② | $R_1 = E7$ |
| ③ | $R_2 = R_0$ AND $R_1$ (B7 AND E7) |
| ④ | $R_1 = 42$ |
| ⑤ | $R_3 = R_2$ OR $R_1$ (A7 OR 42) |
| ⑥ | $R_1 = 81$ |
| ⑦ | $R_0 = R_3$ Xor $R_1$ (E7 Xor 81) |

| $R_0$ |
|---|
| ~~B7~~ |
| 66 |

| $R_1$ | $R_2$ |
|---|---|
| ~~E7~~ | A7 |
| ~~42~~ | |
| 81 | |

| $R_3$ |
|---|
| E7 |

③ AND

```
  1 0 1 1 0 1 1 1
  1 1 1 0 0 1 1 1
-----------------
  1 0 1 0 0 1 1 1
    A       7
```

⑤ OR

```
  1 0 1 0 0 1 1 1
  0 1 0 0 0 0 1 0
-----------------
  1 1 1 0 0 1 1 1   ← E7
```

⑦ Xor

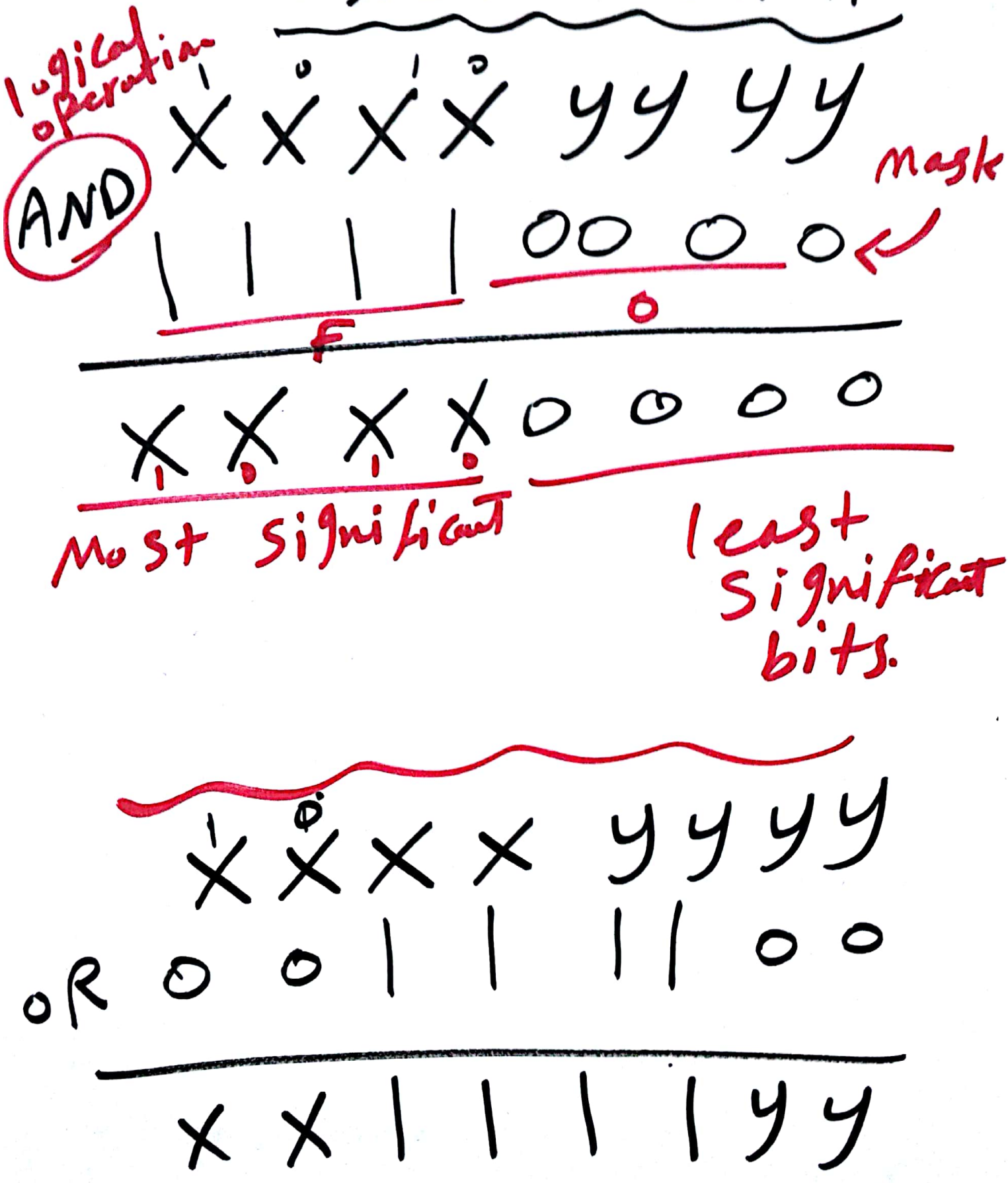
```
  1 1 1 0 0 1 1 1
  0 0 0 0 0 0 0 1
-----------------
  0 1 1 0 0 1 1 0
```

66

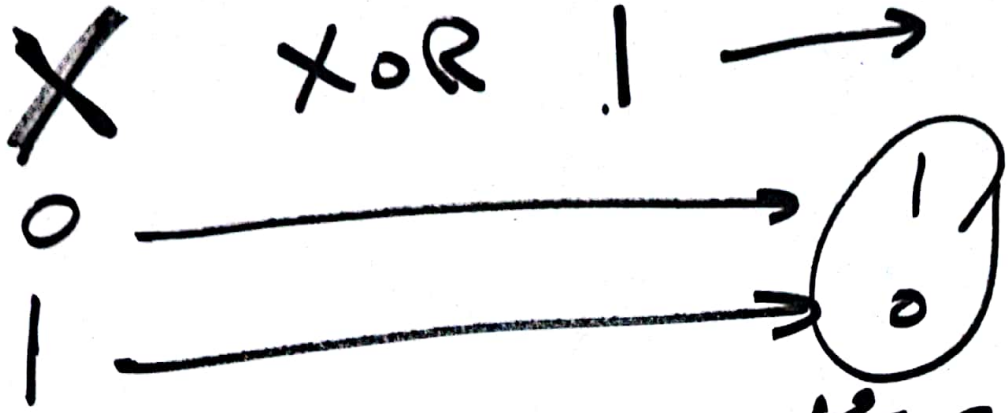
(8) $M[AG] = R_0 = 66$

9) halt.

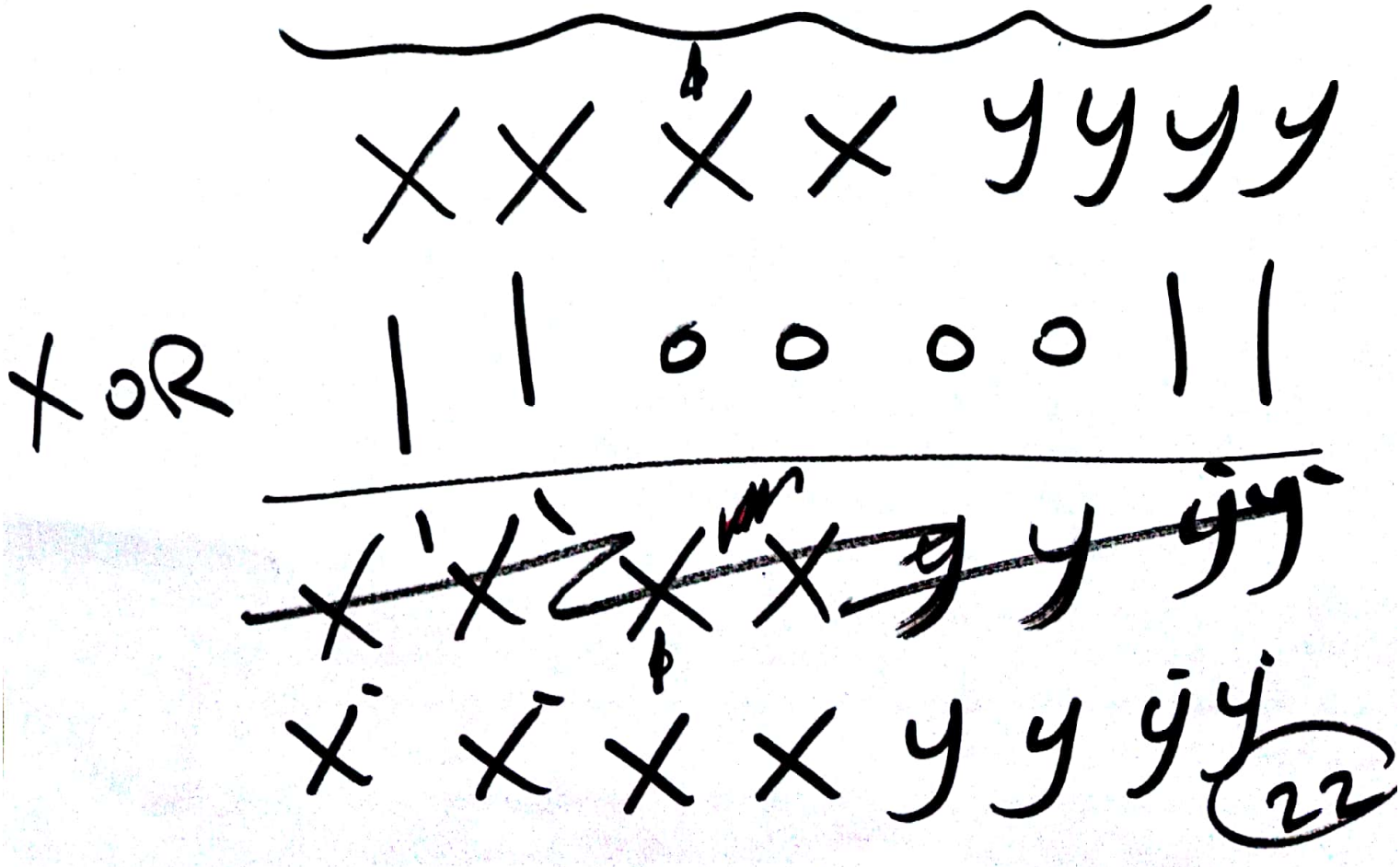
# Logical masks / filters



# XOR




X XOR 1 → $X'$ → dash Prime Complement



AND → 0

OR → 1

XOR → 1's comp. with 1

AND X X X X y y y y

1 1 1 0 0 1 1 1

X X X 0 0 y y y

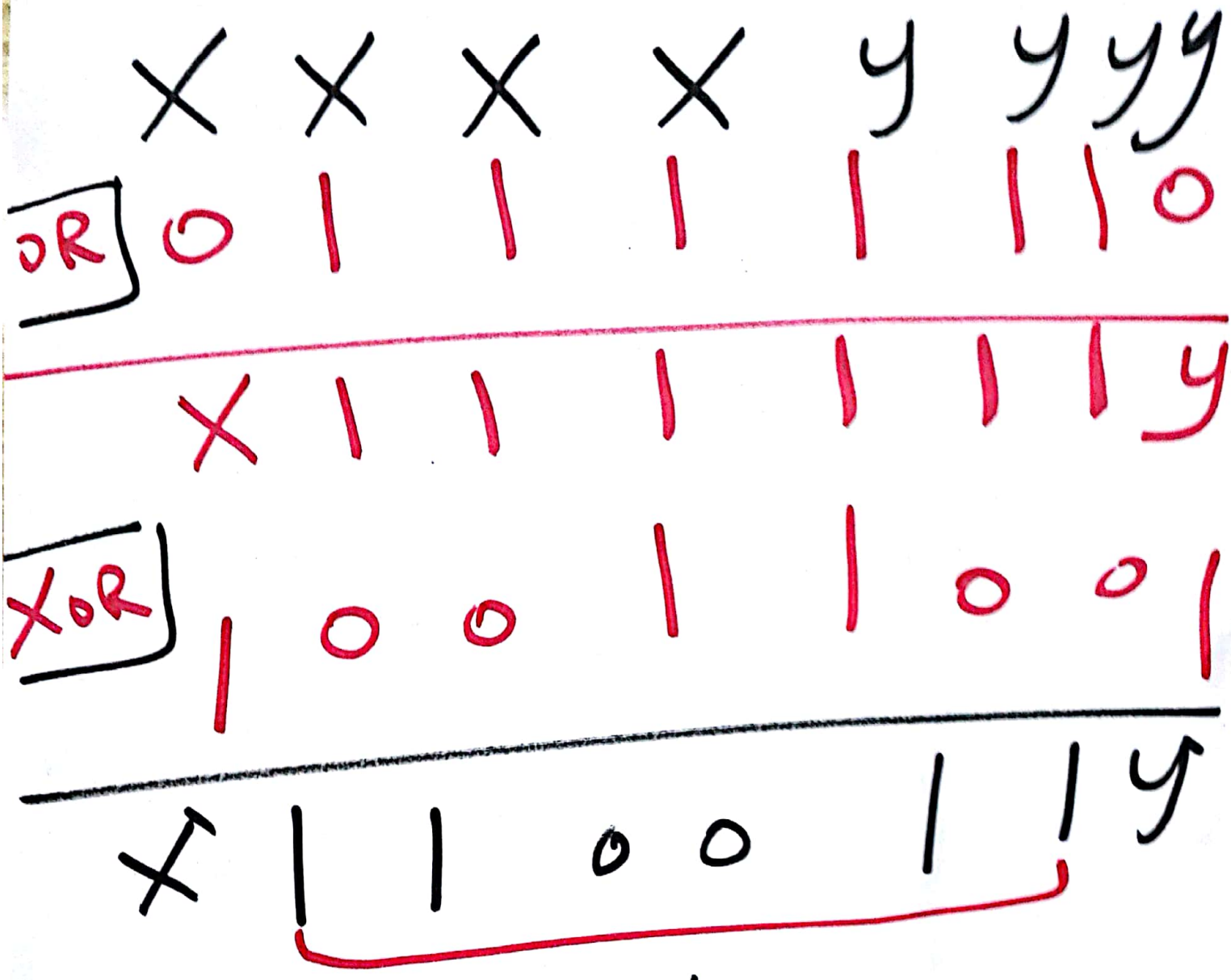
OR 0 1 1 0 0 1 1 0

X 1 1 0 0 1 1 y

XOR 1 0 0 0 0 0 0 1

X` 1 1 0 0 1 1 y`

X` 1 1 0 0 1 1 y`




① هنحل اللى عايزينه ٥ ١ ب ١

OR مع

(X OR y) ← اللى عايزينه ②

ب (١١)

أو (٥)

25 26

x x x x y y y y

AND 1 0 0 0 0 0 0 1

---

x 0 0 0 0 0 0 y

XOR 1 1 1 0 0 1 1 1

---

x' 1 1 0 0 1 1 y'

26 (27)