Bit Manipulation

Decimal → 0-9

Binary → 0's & 1's

Convert DtoB

$(4)_{10} \rightarrow (\ )_2$

2 | 4 → 0
2 | 2 → 0
1

→ 100

$(100)_2 \rightarrow (\ )_{10}$

1 0 0
1×2^2 0×2^1 0×2^0
$4 + 0 + 0 = 4$

Bit-Wise operators

Binary AND &
Binary OR |
Binary XOR ^
Binary one's complement ~
Binary left shift <<
Binary right shift >>

Binary AND &

586 A=0101 B=011

Rules

	output
0 & 0	→ 0
0 & 1	→ 0
1 & 0	→ 0
1 & 1	→ 1

101
110
100 = $(4)_{10}$

Binary OR |

Rules

OR	output
0 | 0	0
0 | 1	1
1 | 0	1
1 | 1	1

5 | 6 A = 101, B = 110

$$\begin{array}{r} 101 \\ 110 \\ \hline 111 \end{array} \rightarrow (7)_{10}$$

$1\times2^2 \quad 1\times2^1 \quad 1\times2^0$

$4+2+1 = 7$

Binary XOR ^

Rules

	output
0 ^ 0	0
0 ^ 1	1
1 ^ 0	1
1 ^ 1	0

5 ^ 6 A = 101, B = 110

$$\begin{array}{r} 101 \\ 110 \\ \hline 011 \end{array} = (3)_{10}$$

Binary one's complement ~

Rules

~0	1
~1	0

~5 A = 0101

$$\frac{101}{010} \rightarrow (2)_{10}$$

(LSB) → Least Significant Bit

(MSB) → Most Significant Bit

5 → 0 0 0 0 0 1 0 1

MSB LSB

(1) 0 0 0 0 1 0 1

↓

-5

1 1 1 1 1 0 1 0

↓

$(-6)_{10}$

2's COMPLEMENT

↓

1's COMPLEMENT (~n)(Magnitude)

↓

add 1

0 0 0 0 0 1 0 1 → 1's comp

+ 1

0 0 0 0 0 1 1 0

↓

-6

$\sim 5 = (-6)_{10}$

Binary Left Shift <<

5<<2 A = 000101

Rules

a << b(2)

a = 0 0 0 1 0 1 1 0 0

0 1 0 1 0 0

$5<2 = (10100)_2$

000101

0 1 0 1 - -

$a << b = a * 2^b$

$5 << 2 = 5 \times 2^2$

$= 5 \times 4 = 20$

Binary Right Shift >>

Rules >>2

0 0 1 0 0 1 0 0

0 0 1 0 0 1

$6 >> 1 = (3)_{10}$

A = 000110

000110

00011

$a << b = a * 2^b$

$a >> b = a / 2^b$

$6/2^1 = 3$

2) Check if a number is odd or Even

0 = 000

1 = 001

2 = 010

3 = 011

4 = 100

5 = 101

6 = 011

LSB

odd → LSB → 1

even → LSB → 0

n & 0 → 0

n & 1 → 1

Ex:- 3

0 1 1

& 0 0 1

0 0 1 → $(1)_{10}$ → odd

Ex:- 4

1 0 0

& 0 0 1

0 0 0

$(0)_{10}$

even

9

1 0 0 1

& 0 0 0 1 → bitmask → 1

0 0 0 1 → $(1)_{10} \neq 0$

↓ odd

operations

1) Get ith bit

0 0 0 0 1 1 1 1 i=2

& [0 0 0 0 0 1 0 0] − 1 << 2(i)

0 0 0 0 0 1 0 0 $\neq 0$ → ith bit 1

For example

0 0 0 0 1 0 1 1

& 0 0 0 0 0 1 0 0

0 0 0 0 0 0 0 0

↓

$= 0$ → ith bit 0

n & (1<<i) → 0 bit zero

→ $\neq 0$ bit one

Ex: n = 10 , i = 2

1 0 1 0

↓

zero → Answer

2) Set ith bit

0 0 0 0 1 0 1 0 $\quad i=2$

↓

0 0 0 0 1 1 1 0

Note: Set ith bit to 1

number = 1 0 1 0 $\quad i=2$

n | (1<<i) =

0 1 0 0 1

1 1 1 0

3) Clear ith bit

10 = 1010 $\quad i=1$

↓

1000 (8)

1<<i

↓

~(1<<i)

~(1<<i) ⇒ ~(0010)

1101

1010

& 1101

1000 $= (8)_{10}$

Note: In short

n = 10, $\rightarrow (1010)_{10}$

i = 1

1<<i

0001

0010 →

~(0010)

1101

1010

& 1101

1000 $= (8)_{10}$

Update ith bit → 0 / 1 + ith

val = 0 or 1

i + (clear, set)

Clear nB = 0

↓

nB << i

0 << i (0) | n

=> n

Set nB = 1

↓

(nB << i) | n

↓

ith bit set