# Lecture 9 : Bit Manipulations - 1

## Converting any system to decimal

① $(100110)_2$

$= \underset{2^5}{1}\ \underset{2^4}{0}\ \underset{2^3}{0}\ \underset{2^2}{1}\ \underset{2^1}{1}\ \underset{2^0}{0}$

$= (37)_{10}$

② $(13)_8 = 8^1 \times 1 + 8^0 \times 3$

$= (11)_{10}$

## Converting from decimal to binary

① $(1037)_{10} = (\underset{10\ 9\ 8\ 7\ 6\ 5\ 4\ 3\ 2\ 1\ 0}{10000001101})_2$

1024 + 8 + 4 + 1

OR

dividing by 2

| | |
|---|---|
| | 1037 |
| 1 | 568 |
| 0 | 184 |
| ⋮ | ⋮ |

end reverse the remainders

^ - XOR

& - AND

| - OR

$a \wedge a = 0$

$a \wedge 0 = a$

$a \wedge 1 \rightarrow a - 1$ odd

$a \wedge 1 \rightarrow a + 1$ even

$a \mid 1 \rightarrow a$

$a \mid 1 \rightarrow a + 1$

$a \,\&\, 1 \rightarrow 0$

$a \,\&\, 1 \rightarrow 1$

$(11)_{10} = (1011)_2$

$(22)_{10} = (10110)_2$

$(44)_{10} = (101100)_2$

$11 << 1 \quad == \quad 11 * 2$

left shift operator

$11 >> 1$ right shift operator

$== \quad 11 // 2$

Check if $6^{th}$ bit is ON/OFF

$k = 6$

$x \;\&\; (1 << (k-1))$

$x >> (k-1) \;\&\; 1$

(26) Count the number of bits which are ON

## Brute Force

```
cnt = 0
while x != 0:
    if x & 1:
        cnt += 1
    x = x >> 1
return cnt
```

O(logN)

## Trick

```
cnt = 0
while x:
    x = x & (x-1)
    cnt += 1
return cnt
```

(27) Given an array, find integer that occurs only once. (All others appear twice)

```
n = len(A)
res = A[0]
for i in range(1, n):
    res = res ^ A[i]
return res
```

$a \hat{} a = 0$