Welcome :)

Agenda : Bit manipulation
Binary Number System
Conversion
Properties
Operators.
Binary rep. of -ve numbers.

Decimal Number System

$$\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}_{base\ 10}$$

$342 \rightarrow 300 + 40 + 2$

$\rightarrow 3 \times 10^2 + 4 \times 10^1 + 2 \times 10^0$

Binary Number System

$$\{0, 1\}_{base\ 2}$$

$110 \rightarrow 1 * 2^2 + 1 * 2^1 + 0 * 2^0 = 4 + 2 + 0 = 6$

$1101 \rightarrow 1 * 2^3 + 1 * 2^2 + 0 * 2^1 + 1 * 2^0$

$\rightarrow 8 + 4 + 0 + 1$

$\rightarrow 13$

Binary to Decimal.

eg:

$$
\begin{array}{cccc}
3 & 2 & 1 & 0 \\
1 & 1 & 0 & 1
\end{array}
$$

$1 * 2^0$

$0 * 2^1$

$1 * 2^2$

$1 * 2^3$

$1 + 0 + 4 + 8 = 13$

eg:

$$
\begin{array}{ccccccc}
6 & 5 & 4 & 3 & 2 & 1 & 0 \\
1 & 0 & 1 & 1 & 0 & 1 & 0
\end{array}
$$

$0 * 2^0$

$1 * 2^1$

$0 * 2^2$

$1 * 2^3$

$1 * 2^4$

$0 * 2^5$

$1 * 2^6$

$2 + 8 + 16 + 64 = 90$
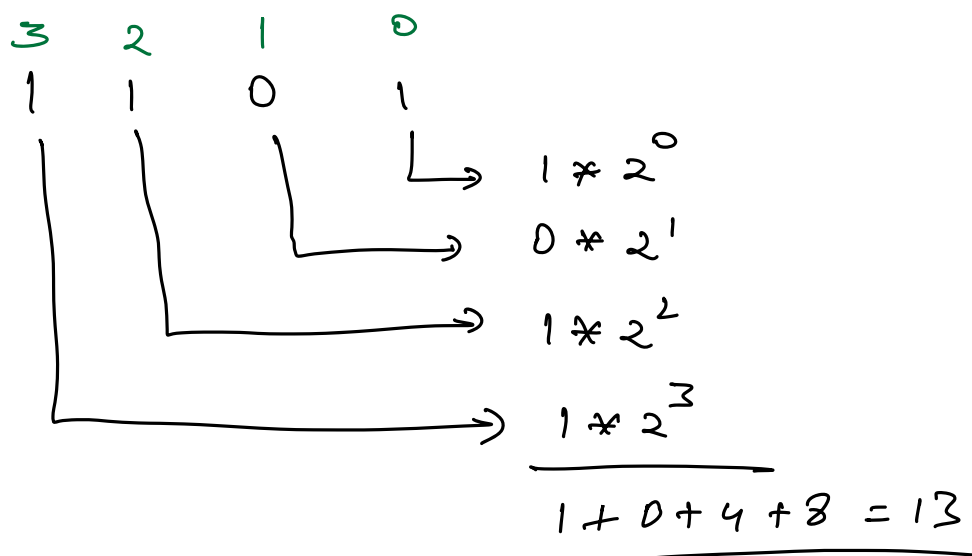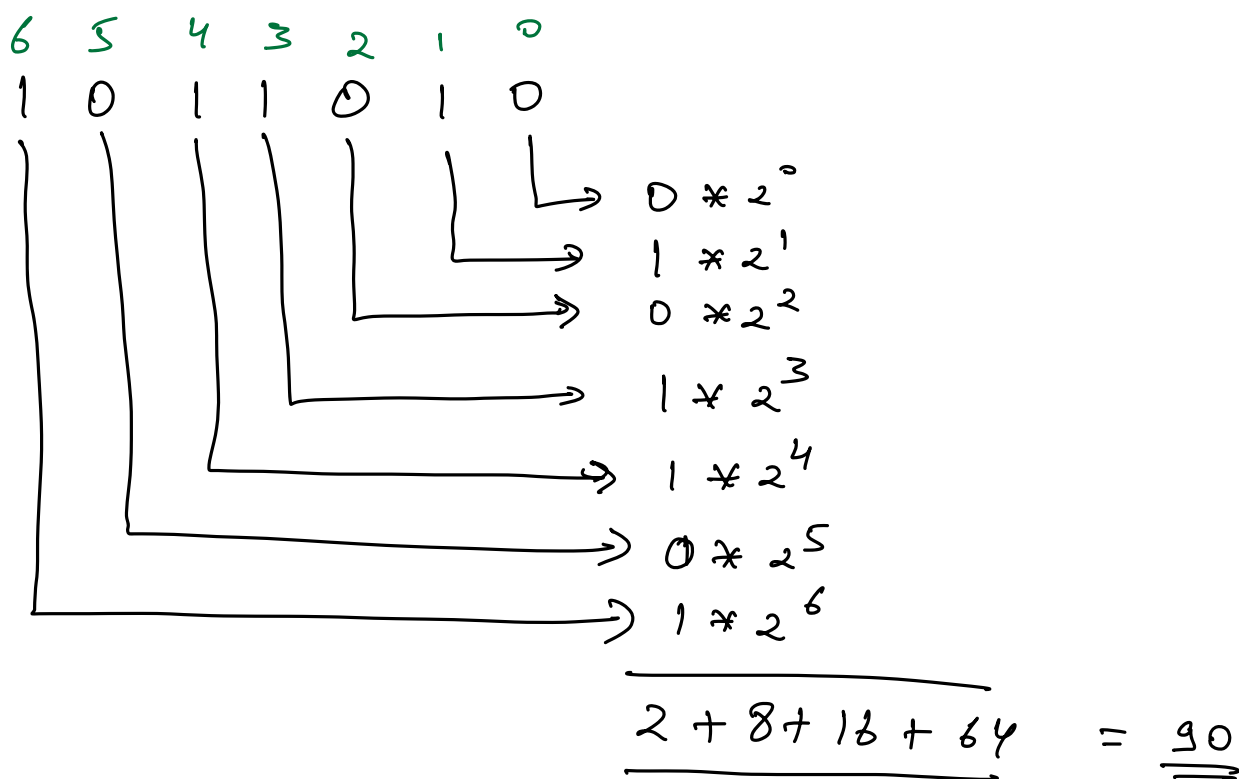
eg:

$(1 \quad 0 \quad \underline{2} \quad 1 \quad 1)_2 \Rightarrow$ invalid binary.

Decimal to Binary

2	20	0
2	10	0
2	5	1
2	2	0
2	1	1
	0	

bottom to top

$\Rightarrow$ 1 0 1 0 0

2	45	1
2	22	0
2	11	1
2	5	1
2	2	0
2	1	1
	0	

1 0 1 1 0 1

Addition

```
  1   1
  3   6   8
  4   5   3
_____
  8   2   1
```

Binary

$0 + 0 \Rightarrow 0$

$0 + 1 \Rightarrow 1$

$1 + 0 \Rightarrow 1$

$1 + 1 \Rightarrow 10$

Q
$\begin{array}{ccc} \overset{1}{1} & \overset{1}{0} & 1 \end{array}$ ⇒ 5

$\begin{array}{ccc} 0 & 1 & 1 \end{array}$ ⇒ 3

$\underline{\begin{array}{cccc} 1\,0 & 0 & 0 \end{array}}$ ⇒ 8

Q
$\begin{array}{ccc} \overset{1}{1} & \overset{1}{0} & 1 \end{array}$ ⇒ 5

$\begin{array}{ccc} 1 & 1 & 1 \end{array}$ ⇒ 7

$\underline{\begin{array}{cccc} 1\,1 & 0 & 0 \end{array}}$ ⇒ 12

Q
$\begin{array}{ccccc} 1 & \overset{1}{0} & \overset{9}{1} & 1 & 0 \end{array}$

$\begin{array}{ccccc} 0 & 0 & 1 & 1 & 1 \end{array}$

$\underline{\begin{array}{ccccc} 2 & 2 & 1 & 0 & 1 \end{array}}$

Bitwise Operators.

AND	OR	NOT	XOR
&	|	! / ~	^

left shift

<<

Right shift

\>>

~0 ⇒ 1
~1 ⇒ 0

1 → set bit
0 → unset bit

↗ Same same
peppy shame.

A	B	A & B	A | B	A ^ B
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

5 & 6

```
    1  0  1
    1  1  0
```
AND ──────────
     1 0 0 ⟹ 4

20 | 45

```
0  1  0  1  0  0
1  0  1  1  0  1
```
──────────────
1 1 1 1 0 1 ⟹ **61**

20 ^ 45

```
0  1  0  1  0  0
1  0  1  1  0  1
```
──────────────
1 1 1 0 0 1 ⟹ **57**

Properties

1) **A & 1**

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

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

A & 1 ──┬─→ 0 ⟹ even number

        └─→ 1 ⟹ odd number.

2) A & 0 ⟹ 0   4) A | A = A

2) A & A ⟹ A   5) A ^ 0 = A

3) A | 0 ⟹ A   6) A ^ A = 0

Binary Rep. of Negative Numbers.

Two's complement method.

1) Convert absolute value to binary.

2) Invert all the bits

3) Add +1 to the no. obtained in step 2.

eg: -5

	7	6	5	4		3	2	1	0
1)	0	0	0	0		0	1	0	1
2)	1	1	1	1		1	0	1	0
									+1
3)	1	1	1	1		1	0	1	1

MSB → most significant Bit

31st bit for int → 1 $-$ve number

→ 0 $+$ve number.

-3

0	0	0	0	0	0	1	1
1	1	1	1	1	1	0	0
							1
1	1	1	1	1	1	0	1

Range

$$8 \quad bits \implies -128 \to 127 \implies -2^{N-1} \to 2^{N-1}-1$$

$$int \implies 32 \; bits \implies -2^{32-1} \to 2^{32-1}-1 \qquad \underline{2 \times 10^9}$$

$$long \implies 64 \; bits \implies -2^{64-1} \to 2^{64-1}-1 \qquad \underline{9 * 10^{18}}$$

$$\underline{-128}$$

$$1\;0\;0\;0 \quad 0\;0\;0\;0$$
$$0\;1\;1\;1 \quad 1\;1\;1\;1$$
$$1$$
$$\overline{1\;0\;0\;0\;0\;0\;0\;0} \implies \underline{-128}$$

$$int \; a = 10^5$$
$$int \; b = 10^6$$
$$int \; c = a * b \implies \underline{overflows}$$
$$long \; c = a * b \quad ✗$$
$$long \; c = long\,(a * b) \quad ✗$$
$$long \; c = (long)a * b \quad ✓$$

	Contest	
15 →	17	18th?
Tuesday	Thursday	