Bit Manipulation

- Introduction to operators and(&), or(|), xor(^), not(~), left shift(<<) and right shift(>>).

- Counting no. of set bits in a number x:

```
count = 0;
while(x)
{       x &= ( x-1 ); // Resets last set bit
        count++;
}
return count;
```

- Check if a number n is power of 2:

```
return n && ( ( n & ( n-1 ) ) == 0 );
```

- Finding position of first set bit from LSB

```
return n ^ ( n & ( n-1 ) );
```

- Checking i^{th} bit of a number x is set or not:

```
return ( x & 1<<i ) > 0;
```

- Set i^{th} bit of number N

```
N |= ( 1<<i )
```

- Clear i^{th} bit of number N

```
N &= ( ~( 1<<i ) )
```

- Update i^{th} bit to v of a number N
  1) Clear i^{th} bit
  2) N |= (v<<i)

- Count no. of set bits in number from 1 to N.

```
for(int i = 0; i <= n; i++)
        Ans[i] = Ans[i>>1] + (i&1);
```

Q - What is the maximum value that we can get by choosing at most k values from 1 to N (no repetition) and xor-ing them

```
Ans -  if(k==1)
               return n;
       else
               return n ^ ( ~n );
```

Q - Generate all subsets of a set of size N.

```
Ans -  for(int i = 0; i < ( 1<<N ); i++)
       {       for(int j = 0; j < N; j++)
                       if( i & ( 1<<j ) )
                               printf(“%d ”,a[j]);
               printf(“\n”);
       }
```

Q - What will be the xor of all numbers from 0 to N.

```
Ans -  if( N%4 == 1)
               return 1;
       if( N%4 == 2 )
               return N+1;
       if( N%4 == 3 )
               return 0;
       else
               return N;
```

Q - Find XOR of all Numbers from L to R.

Ans - (Xor(0 to L-1) ^ Xor(0 to R)) // Xor function using above method

Q - Find a number N which lies between L to R with maximum set bits. If there are many such numbers return the minimum one.

```
Ans -  ans = L
       for(int i = 1; i < 60; i++) // log(INT_MAX) = 60
       {       if( ans | ( 1<<i ) <= R)
                       ans |= ( 1<<i );
       }
       return ans;
```

Practice Problems:

a. https://leetcode.com/problems/convert-to-base-2/
b. https://leetcode.com/problems/single-number/
c. https://leetcode.com/problems/single-number-ii/
d. https://leetcode.com/problems/single-number-iii/
e. https://leetcode.com/problems/counting-bits/
f. https://www.geeksforgeeks.org/minimum-xor-value-pair/
g. https://leetcode.com/problems/subsets/
h. https://www.interviewbit.com/problems/count-of-rectangles-with-area-less-than-the-given-number/
i. https://leetcode.com/problems/bitwise-and-of-numbers-range/
j. https://leetcode.com/problems/maximum-product-of-word-lengths/