

# **MATHEMATICS FOR PROGRAMMING**

# NUMBER SYSTEM

- Remember Decimal and Binary?
- How many digits  $\rightarrow$  *base*
- Base 10: Decimal [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
- Base 2: Binary [0, 1]
- Base 8: Octal [0, 1, 2, 3, 4, 5, 6, 7]
- Base 16: Hexadecimal [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, *A, B, C, D, E, F*]

Decimal	Binary	Octal	Hexadecimal
0	0000	000	0000
1	0001	001	0001
2	0010	002	0002
3	0011	003	0003
4	0100	004	0004
5	0101	005	0005
6	0110	006	0006
7	0111	007	0007
8	1000	010	0008
9	1001	011	0009
10	1010	012	A
11	1011	013	B
12	1100	014	C
13	1101	015	D
14	1110	016	E
15	1111	017	F

# CONVERT DECIMAL TO DECIMAL

- Just for the fun of it!

$$\begin{aligned} &273 \\ &= 200 + 70 + 3 \\ &= 2 \times 100 + 7 \times 10 + 3 \times 1 \\ &= 2 \times 10^2 + 7 \times 10^1 + 3 \times 10^0 \\ &= 2 \times b^2 + 7 \times b^1 + 3 \times b^0 \end{aligned}$$

For decimal:  $b = 10$

# CONVERT BINARY TO DECIMAL

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1101

$$= 1 \times b^3 + 1 \times b^2 + 0 \times b^1 + 1 \times b^0$$

$$= 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$= 1 \times 8 + 1 \times 4 + 0 \times 2 + 1 \times 1$$

$$= 8 + 4 + 0 + 1$$

$$= 13$$

**For binary:  $b = 2$**

# CONVERT DECIMAL TO BINARY

- *Decimal value 13 → binary?*
- $13 \div 2 = 6; \text{remainder} = 1$  (LSB: goes to the right)
- $6 \div 2 = 3; \text{remainder} = 0$
- $3 \div 2 = 1; \text{remainder} = 1$
- $1 \div 2 = 0; \text{remainder} = 1$  (MSB: goes to the left)
- *Binary: 1101*

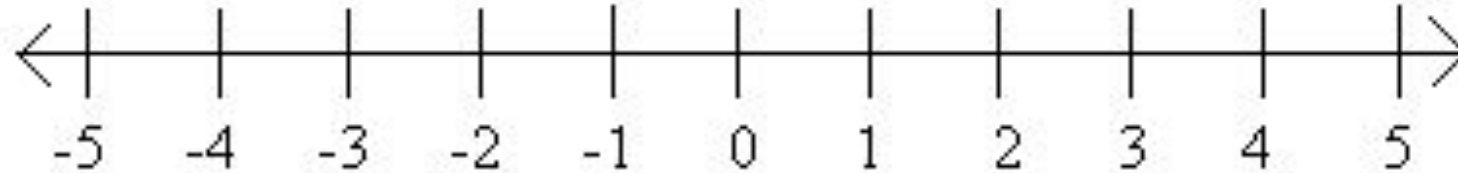
# TYPES OF NUMBERS

*Real number: any point on the number line*

*Positive number (right to the zero)*

*Negative number (left to the zero)*

*Non – negative number (Positive and zero)*



*Natural Numbers:  $\{1, 2, 3, \dots\}$*

*Whole Numbers:  $\{0, 1, 2, 3, \dots\}$*

*Integers:  $\{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$*

*Rational and Irrational numbers*

# LET'S LEARN ABOUT DIVISION

Diagram illustrating the division process:

$$\begin{array}{r} \text{Dividend / ভাজ্য} \\ 5 \ ) \ 17 \ ( \ 3 \\ \underline{15} \\ 2 \end{array}$$

Labels and arrows:

- Dividend / ভাজ্য**: Points to the number 17.
- Divisor / ভাজক**: Points to the number 5.
- Quotient / ভাগফল**: Points to the number 3.
- Remainder / ভাগশেষ**: Points to the number 2.



# DIVISIBILITY CHECK

- How to tell if a number  $P$  is divisible by another number  $Q$ ?
  - Pause the video!
  - Think about applying what we have just learned
- There are two ways:
  - Check if the remainder is zero.
    - $12 \% 3 = 0 \rightarrow 12$  is divisible by 3
    - $12 \% 5 = 2 \rightarrow 12$  is NOT divisible by 5
  - What do we get if we just do the division?
    - $12/3 = 4 \rightarrow$  Integer  $\rightarrow 12$  is divisible by 3
    - $12/5 = 2.4 \rightarrow$  NOT integer  $\rightarrow 12$  is NOT divisible by 5

# PRIME AND COMPOSITE NUMBERS

- Think of natural numbers / counting numbers

– 1,2,3,4,5, ...

- Factor: What does it mean when we say

*P is a “factor” of Q?*

*Answer: P divides Q evenly (Remainder is 0). Example: 3 is a factor of 12.*

- **Prime:** Only two factors. 1 *and itself*.
- **Composite:** There exists at least one factor other than 1 *and itself*.

# PRIME AND COMPOSITE NUMBERS

∴ Is 15 a prime number?

- 15 is divisible by: 1,3,5,15. Not prime!

- Is 19 a prime number?

- 19 is divisible by: 1,19. Prime!

- What about 1? Is it a prime or composite?

- Special case. Neither!

# EVEN AND ODD NUMBERS

- Even: জোড় সংখ্যা
- Odd: বিজোড় সংখ্যা
- *Even*: 0, 2, 4, 8, 10, ...
- *Odd*: 1, 3, 5, 7, 9, ...
- How to check?
  - Pause the video again and think!
  - Divide the number with 2
  - If remainder is 0, even! Otherwise, odd!
- Dividing by 2 sounds binary, right?
  - Convert the numbers to binary and see if you can find a pattern for even and odd numbers there.

# SUMMARY

- We are more comfortable with the number systems
  - Especially binary numbers!
- Learned the types of numbers and how they are related
- Reviewed the division process and terminologies.
- Divisibility check and its use
- Prime numbers and how to detect them when you see one!
- Even odd numbers, with a brain teaser!



**NEXT**





**NEXT**



# PRACTICE DAY

- 1101011 is a binary number. Find its equivalent decimal number.
- Find the binary representation for 73 (a decimal number).
- Is 77 a prime number?
- What about 169? Prime or composite?
- Find out the 12<sup>th</sup> prime number.
- Find out sum of first  $n$  odd numbers. Try  $n = 1, 2, 3, \dots$ 
  - Can you see any pattern?