Class 10: **Wednesday February 21**

ALL ABOUT THAT BASE: BINARY, QUINARY and SEPTENARY NUMBERS

THE BINARY NUMBER SYSTEM

Definition

A **binary** number is a number which is written in the base-2 number system, which means that only two numerical symbols are allowed to be used: 1 (one) and 0 (zero).

The binary system for representing numbers is used extensively in almost all electronic devices, where one represents ON and zero represents OFF.

HISTORICAL BACKGROUND

The discovery and popularization of the binary numbers are attributed to the great German mathematician and philosopher **Gottfried Wilhelm Leibniz** (1646-1716), who is most well-known as the co-inventor of the Calculus (with **Sir Isaac Newton**). The binary numbers were central to Leibniz' theological belief system because he felt they represented the principle of *creatio ex nihilo* (the creation of something out of nothing).

+	0	1
0		
1		

x	0	1
0		
1		

EXAMPLE

Let's show that $110001_{two} = 49$

Exercise

What is 34 in base two?

GroupWork

Evaluate the following expressions.

$111_{two} + 101_{two}$ $11_{two} \times 101_{two}$

$111_{two} - 101_{two}$ $1110_{two} - 101_{two}$

THE BASE 5 NUMBER SYSTEM

Although not as popular or well-known (or practical!) as the binary system, the **quinary** number system also has its uses.

EXAMPLE

$22_{five} + 14_{five}$ $3_{five} \times 11_{five}$

EXERCISE

$43_{five} - 14_{five}$ $111_{five} + 141_{five}$

BASE FIVE ADDITION

+	0	1	2	3	4
0					
1					
2					
3					
4					

BASE 5 MULTIPLICATION

×	0	1	2	3	4
0					
1					
2					
3					
4					

Other Number Systems
Any positive whole number can be used as potential base for a number system. Some other popular ones are octal (base 8), duodecimal (base 12), hexadecimal (base 16), vigesimal (base 20), and sexagesimal (base 60).

Conversion Of A Number from One Base to Another Base
Generally if you want to convert a number from one base (say Base 5) to another (say Base 7) one converts to Base 10 in between.

EXAMPLE
Let's convert 123_{five} to base 7. First convert to base 10

$123_{five} = \mathbf{1} \times 5^2 + \mathbf{2} \times 5^1 + \mathbf{3} \times 5^0 = 25 + 10 + 3 = 38_{ten}$

Then we convert 38_{ten} to base 7 by using division repeatedly and noting the remainders.

$38 \div 7 = 5$ R **3** and $5 \div 7 = 0$ R **5**. So $38_{ten} = 53_{seven} = 123_{five}$

Exercise
Convert 34_{five} to binary (base 2) and decimal (base 10) and vigesimal (base 20)!

34_{five} =---------$_{two}$

34_{five} =---------$_{ten}$

34_{five} =---------$_{twenty}$