

## Signed Numbers & Binary Codes

### Weighted Numeric Codes

Binary coding systems where each binary bit is assigned a specific "weight." These weights allow the code to mathematically represent the decimal number as the sum of these weighted bits.

- **BCD (Binary-Coded Decimal):** In BCD, each decimal digit (0–9) is represented by a 4-bit binary number. The weights of the four binary positions are **8, 4, 2, 1**.
- **2421 Code:** A weighted code where the weights of the binary digits are **2, 4, 2, 1**. This code is still used today in digital clocks and calculators.
- **8, 4, -2, -1 Code:** A code with weights **8, 4, -2, -1**. It's a curious design where some weights are negative. Negative weights allow the code to self-check and simplify certain computations.
- **Biquinary Code:** A hybrid code using two parts: a quinary zone (5 possible states) and a binary zone (2 bits for additional precision). Biquinary codes were used in early computers for error detection because of their distinct zones.

### Non-Weighted Numeric Codes

Non-weighted codes do not assign fixed positional weights to bits. Instead, they rely on specific rules to represent numbers.

- **Excess-3 Code:** A self-complementing code where each decimal digit is represented by the binary equivalent of  $N + 3$  (where  $N$  is the decimal number).
- **Gray Code:** A sequential binary code where only one bit changes between consecutive numbers. Gray codes reduce errors in systems where binary digits transition rapidly. They are used in encoders and error-sensitive applications.

### Other Properties of Binary Codes

- **Self-Complementing:** A code is self-complementing if the binary complement of a digit's code corresponds to the 9's complement of the decimal digit.
- **Error Correcting:** Some codes, like Hamming codes, are designed to detect and correct errors. While standard binary codes like BCD lack this capability, advanced codes incorporate error-correcting properties.
- **Sequential Code:** A code where only one bit changes between successive numbers (e.g., Gray Code).

# CSARCH1 Introduction to Computer Organization and Architecture

## Binary Code Cheat Sheet Version 1

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Binary	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
8 4 2 1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2 4 2 1	0	1	2	3	4	-	-	-	-	-	-	5	6	7	8	9
Excess-3	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
8 4 -2 -1	0	-	-	-	4	3	2	1	8	7	6	5	-	-	-	6
Gray Code	0	1	3	2	6	7	5	4	15	14	12	13	8	9	11	10

## Binary Code Cheat Sheet Version 2

Decimal	BCD	2421	Excess-3	8 4 -2 -1	Biquinary	Gray
0	0000	0000	0011	0000	0100001	0000
1	0001	0001	0100	0111	0100010	0001
2	0010	0010	0101	0110	0100100	0011
3	0011	0011	0110	0101	0101000	0010
4	0100	0100	0111	0100	0110000	0110
5	0101	1011	1000	1011	1000001	0111
6	0110	1100	1001	1010	1000010	0101
7	0111	1101	1010	1001	1000100	0100
8	1000	1110	1011	1000	1001000	1100
9	1001	1111	1100	1111	1010000	1101

Binary Code Properties Cheat sheet

Binary Codes	Weighted	Self-complementary	Sequential	Error-detecting
<b>BCD</b>	YES	NO	NO	NO
<b>2421</b>	YES	YES	NO	NO
<b>Excess-3</b>	YES	YES	NO	NO
<b>8, 4, -2, -1</b>	YES	YES	NO	NO
<b>Biquinary</b>	YES	NO	NO	YES
<b>Gray Code</b>	NO	NO	YES	YES