Radices

Dec	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Oct	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17	20	21
Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11

Binary Arithmetic (Examples)

Signed (8 Bit)	1's Comp (8 Bit)	2's Comp (8 Bit)	No.
10100111	11011000	11011001	-39
10101101	11010010	11010011	-55
11000101	10111010	10111011	-69

2's Comp: Flipped Binary when -ve, +1
1's Comp: Flipped Binary when -ve
(2 Zeros: 0000 and 1111)
Signed: MSB Flipped when -ve

Binary Formats: N-Bit Number
Excess-$2^{(N-1)}$: $-2^{(N-1)} <= x <= (2^{(N-1)} -1)$
2's Comp: $-2^{(N-1)} <= x <= (2^{(N-1)} -1)$
1's Comp: $-(2^{(N-1)} -1) <= x <= (2^{(N-1)} -1)$
Signed-Mag: $-(2^{(N-1)} -1) <= x <= (2^{(N-1)} -1)$
Unsigned-Mag: $0 <= x <= 2^N - 1$

Binary Coded Decimal (BCD)

Structure:
- Each decimal digit (0–9) is represented by a 4-bit binary number.
- BCD represents multi-digit numbers by encoding each digit individually in binary.
- Valid BCD values: 0000 to 1001 (0–9).
- Invalid BCD values: 1010 to 1111 (10–15).

Conversion:
Decimal to BCD
1. Split number into individual digits
2. Convert each digit to 4-bit binary
e.g. 3579 -> 3 5 7 9 -> 0011 0101 0111 1001
BCD to Decimal
1. Group the BCD bits into 4 chunks
2. Convert each chunk to a decimal digit
e.g. 0011 0101 0111 1001 -> 3 5 7 9 -> 3579
Minimum D Flip-Flops
- 1 D flip-flop stores 1 bit.
- Each BCD digit = 4 bits.
- For an N-digit decimal number:
-- Minimum flip-flops = 4 × N
e.g. 3579 = 4 digits -> 4x4 =16 flip-flops