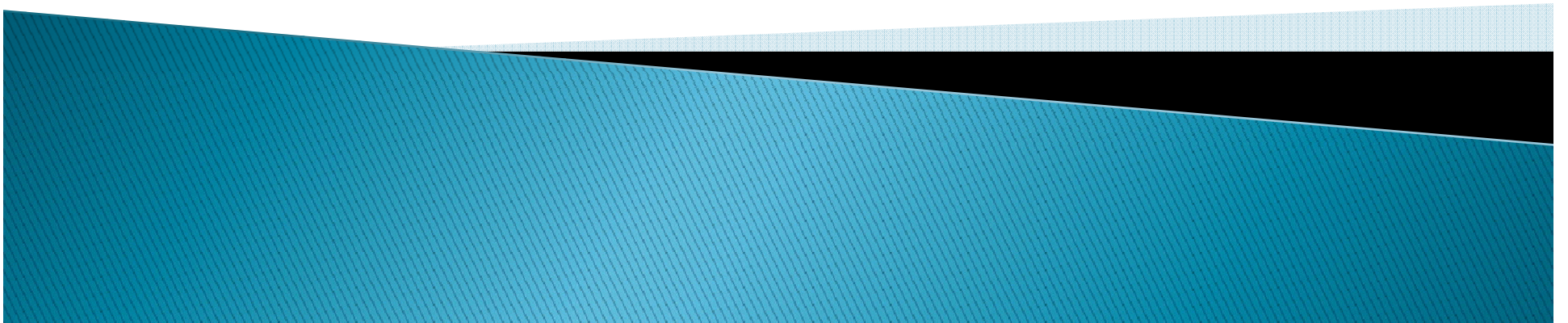


Computer Science 210

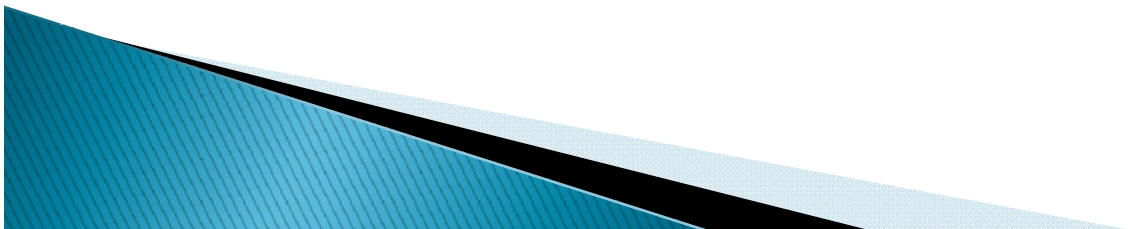
tutorial 1

Data representation



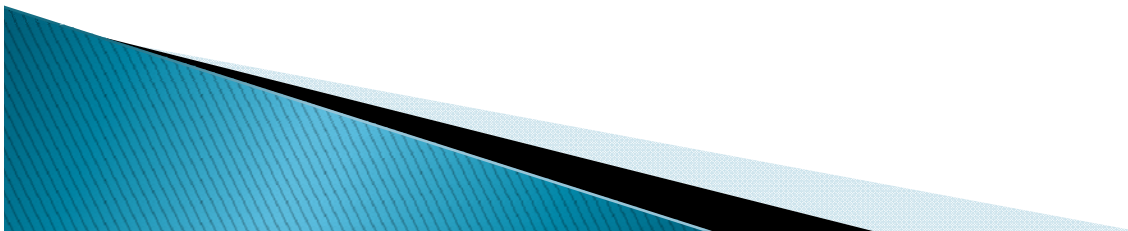
Decimal number system

- ▶ 0 1 2 3 4 5 6 7 8 9
- ▶ It's a everyday used number system, base 10.
- ▶ Is it the only base used by man kind before the age of computers?
- ▶ Sumerians between 8000 and 3500 BC and later the Babylonia used base 60 number system.
- ▶ -> First number system?



Other number systems in computer science

- ▶ Base 2 – binary: 01010101001110_2
- ▶ Base 8 – octal: 1234567012372_8
- ▶ Base 16 – hexadecimal: $AF03DE4_{16}$



Dec-Hex-Oct-Bin table

Dec	Hex	Oct	Bin	Dec	Hex	Oct	Bin
0	0	000	00000000	16	10	020	00010000
1	1	001	00000001	17	11	021	00010001
2	2	002	00000010	18	12	022	00010010
3	3	003	00000011	19	13	023	00010011
4	4	004	00000100	20	14	024	00010100
5	5	005	00000101	21	15	025	00010101
6	6	006	00000110	22	16	026	00010110
7	7	007	00000111	23	17	027	00010111
8	8	010	00001000	24	18	030	00011000
9	9	011	00001001	25	19	031	00011001
10	A	012	00001010	26	1A	032	00011010
11	B	013	00001011	27	1B	033	00011011
12	C	014	00001100	28	1C	034	00011100
13	D	015	00001101	29	1D	035	00011101
14	E	016	00001110	30	1E	036	00011110
15	F	017	00001111	31	1F	037	00011111

Transforms binary, octal, and hexadecimal to decimal

$$110011_2 = 51_{10}$$

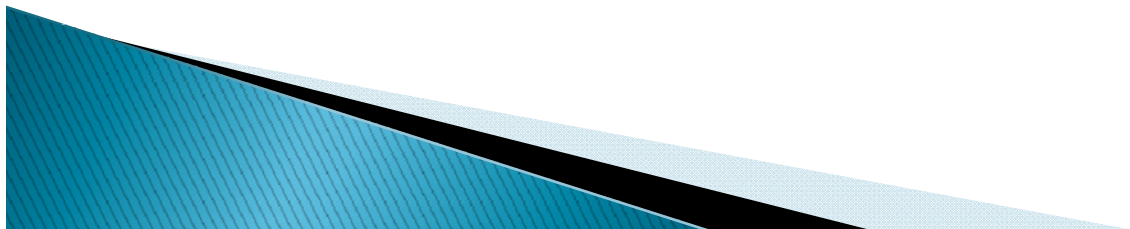
- $110011_2 = 1 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 51_{10}$

$$33617_8 = 28439_{10}$$

- $33617_8 = 3 \times 8^4 + 3 \times 8^3 + 6 \times 8^2 + 1 \times 8^1 + 7 \times 8^0 = 28439_{10}$

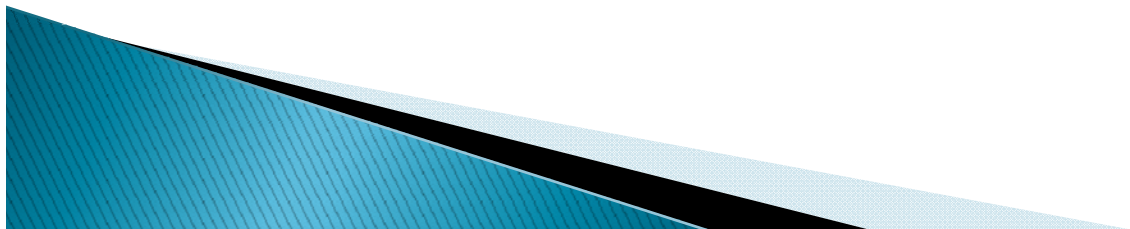
$$ACF7_{16} = 44279_{10}$$

- $ACF7_{16} = 10 \times 16^3 + 12 \times 16^2 + 15 \times 16^1 + 7 \times 16^0 = 44279_{10}$



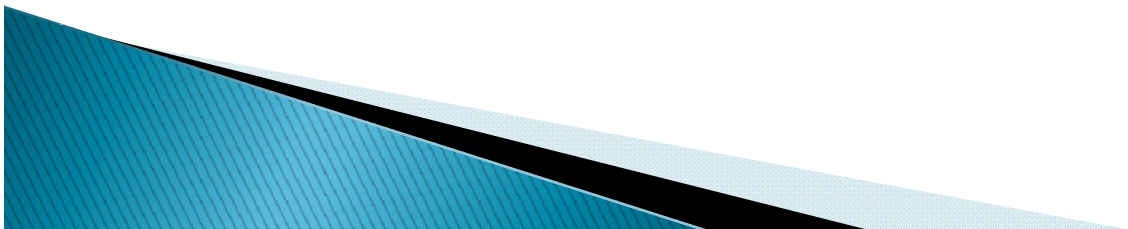
Transforms decimal, octal, and hexadecimal to binary

- **One method:** subtract largest power of 2 smaller than N until you reach 1:
- $81_{10} = 64 + 16 + 1 = 2^6 + 2^4 + 0 + 0 + 0 + 2^0 = 1010001_2$
- ***Tip: Best way to transform from decimal to octal is to go via Binary Octal representation to binary representation***
- $745_8 = 7 \times 8^2 + 4 \times 8^1 + 5 \times 8^0$
In Binary: 111 100 101 = 111100101_2
- $D8F_{16} = 13 \times 16^2 + 8 \times 16^1 + 15 \times 16^0 = 3471_{10}$
- In Binary: 1101 1000 1111 = 110110001111_2



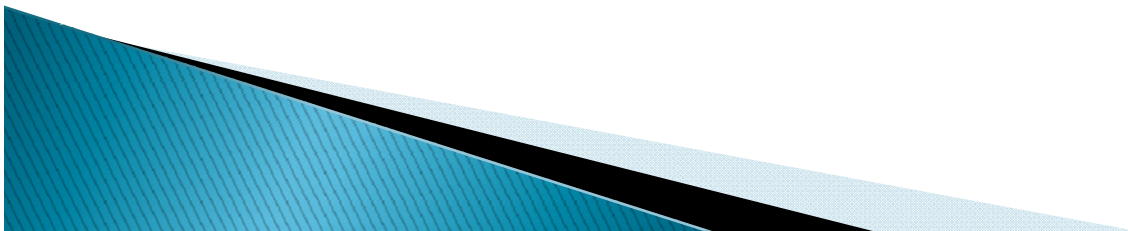
Transforms binary, decimal, and hexadecimal to octal

- $110100101010110_2 = 110\ 100\ 101\ 010\ 110_2 = 64526_8$
- $161_{10} = 128 + 32 + 1 = 2^7 + 2^5 + 0 + 0 + 0 + 0 + 2^0$
 $= 10100001_2 = 010\ 100\ 001_2 = 241_8$
- $AEF78_{16} = 1010\ 1110\ 1111\ 0111\ 1000_2$
 $= 010\ 101\ 110\ 111\ 101\ 111\ 000_2$
 $= 2567570_8$



Exercises

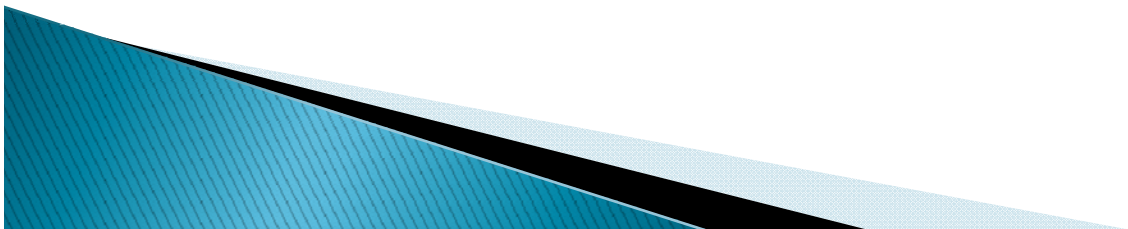
- ▶ 1. Transform to binary
 - 712_8
 - 6634_8
 - 236_{10}
 - 729_{10}
 - 9394_{16}
 - $AFED_{16}$



Exercises

▶ 2. Transform to Decimal

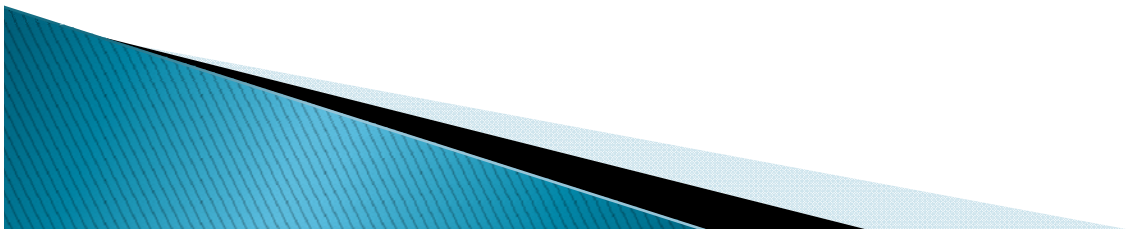
- 1010110101001_2
- 111111111111111111_2
- $CCDE_{16}$
- 800_{16}
- 7777_8
- 4000_8



Exercises

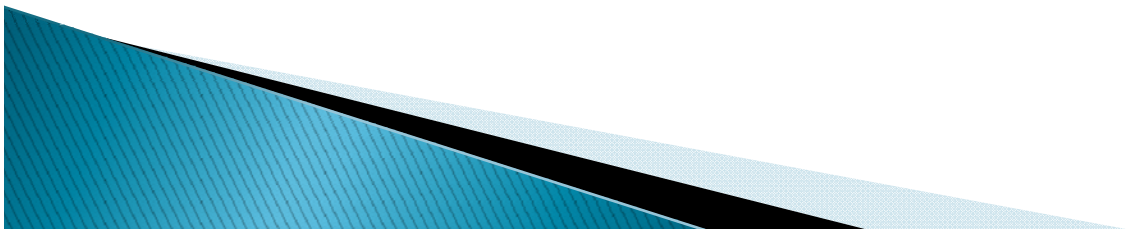
▶ 3. Transform to Octal

- 1010110101001_2
- 11111111111111111111_2
- $93F4_{16}$
- $AFFF_{16}$
- 1111_{10}
- 9999_{10}



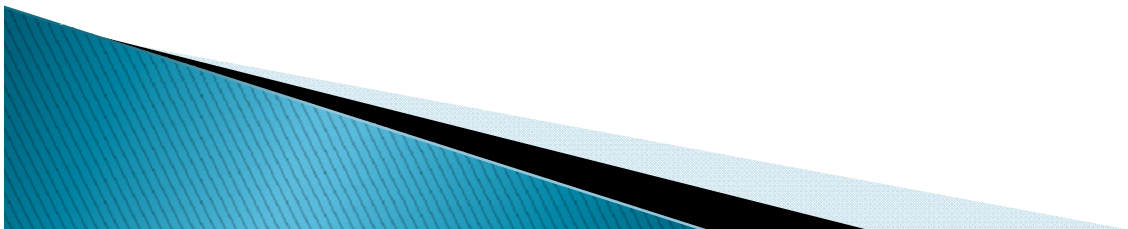
Exercises

- ▶ 4. Transform to Hexadecimal
 - $101010111101010001001010101_2$
 - 111111111111111111_2
 - 712_8
 - 6634_8
 - 1111_{10}
 - 9999_{10}



Exercises

- ▶ 5. Transform to base X to base X^{**k} , $k=1, 2, 3 \dots n$.
 - 2212122221 (base 3) to its base 9 number
 - 2212122221 (base 3) to its base 27 number
 - 3123213231 (base 4) to its base 16 number



Solution

1.

$$712_8 = 111001010_2$$

$$6634_8 = 110110011100_2$$

$$236_{10} = 11101100_2$$

$$729_{10} = 1011011001_2$$

$$9394_{16} = 1001001110010100_2$$

$$AFED_{16} = 1010111111101101_2$$

2.

$$1010110101001_2 = 5545_{10}$$

$$111111111111111_2 = 65535_{10}$$

$$CCDE_{16} = 52446_{10}$$

$$800_{16} = 2048_{10}$$

$$7777_8 = 4095_{10}$$

$$4000_8 = 2048_{10}$$

3.

$$1010110101001_2 = 12651_8$$

$$111111111111111_2 = 177777_8$$

$$93F4_{16} = 111764_8$$

$$AFFF_{16} = 127777_8$$

$$1111_{10} = 2127_8$$

$$9999_{10} = 23417_8$$

4.

$$10101011101010001001010101_2 = 2AEA255_{16}$$

$$111111111111111_2 = FFFF_{16}$$

$$712_8 = 1CA_{16}$$

$$6634_8 = D9C_{16}$$

$$1111_{10} = 457_{16}$$

$$9999_{10} = 270F_{16}$$

5.

$$2212122221 \text{ (base 3)} = 85587_9$$

$$2212122221 \text{ (base 3)} = 2NHP_{27}$$

$$3123213231 \text{ (base 4)} = DB9ED_{16}$$

