TECH 3232

Digital Technology

Number Systems

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Decimal – Base 10

- Decimal has digits 0 - 9.
- Number system we commonly use in our day to day lives.

Hundreds	Tens	Ones
10^2	10^1	10^0

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Binary – Base 2

- Binary has digits 0 and 1.
- Commonly used in digital logic, computers and networking.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

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Worked Problem

Convert 111 Dec to Binary

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0	1	1	0	1	1	1	1

111 dec
-64
47
-32
15
-8
7
-4
3
-2
1
-1 =0

4

Worked Problem

Convert 210 Dec to Binary

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	1	0	1	0	0	1	0

210
-128
82
-64
18
-16
2

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Convert 100 to binary
(division method)

Convert 100 to binary using division method.

Division	Quotient	Remainder

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Example Binary to Decimal Conversion

Convert 1010110_2 to decimal

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

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Example Binary to Decimal Conversion

Convert 11010010_2 to decimal

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

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Octal – Base 8

- Octal has digits 0 though 7.
- Used to be used in computers (but rarely used today).
- Why base 8? Because 3 bits can be converted to decimal digits 0 -> 7.

4	2	1
2^2	2^1	2^0

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Example Octal to Decimal Conversion

Convert 127 Octal to Decimal.

4	2	1	4	2	1	4	2	1
256	128	64	32	16	8	4	2	1

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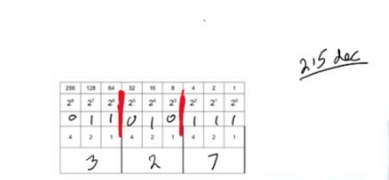
Worked Problem

Convert 011010111 binary (215 dec) to Octal)



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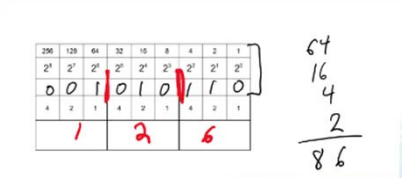
Worked Problem

Convert 001010110 binary to dec (86) and Octal (126)



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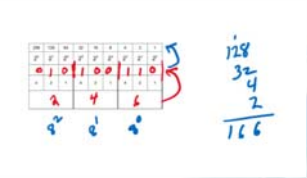
Worked Problem

Binary 010100110 back to dec 166 and to octal 246



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Example Octal to Decimal Conversion

Convert 476 Octal to Decimal.

4	2	1	4	2	1	4	2	1
256	128	64	32	16	8	4	2	1

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Hex – Base 16

If Binary (base 2) uses digits 0 and 1 and Octal (base 8) uses digits 0 though 7.

What would Base 16 use?

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Hex – Base 16

If Binary (base 2) uses digits 0 and 1 and Octal (base 8) uses digits 0 though 7.

What would Base 16 use?

But we represent 10 though 15 as “A” though “F”

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Hex – Base 16

Base 10	Base2	Base 16		Base 10	Base2	Base 16
0	0000	0		8	1000	8
1	0001	1		9	1001	9
2	0010	2		10	1010	A
3	0011	3		11	1011	B
4	0100	4		12	1100	C
5	0101	5		13	1101	D
6	0110	6		14	1110	E
7	0111	7		15	1111	F

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Hex – Base 16

- Most commonly used in computers and networking (error messages in windows and mac addressing)
- Why base 16? Because 4 bits can be converted to decimal digits 0 -> 15.

8	4	2	1
2^3	2^2	2^1	2^0

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Example Decimal to Hex Conversion

Convert 100 to Hex via Binary.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
8	4	2	1	8	4	2	1

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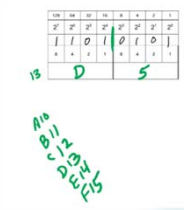
Worked example

Binary 11010101 to Hex



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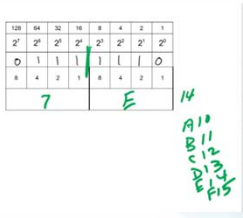
Worked Example

Binary 01111110 to hex



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Binary Coded Decimal

- Binary Coded Decimal (BCD for short) is a way of storing decimal digits in a binary format.
- Each nibble (4 bits) is used to store a digit 0-9 of the decimal value.

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Example Decimal to BCD Conversion

Convert 97 Decimal to BCD.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
8	4	2	1	8	4	2	1

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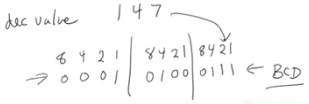
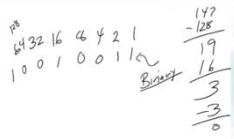
Worked Example

Dec 147 to BCD



DEC 147 and Binary



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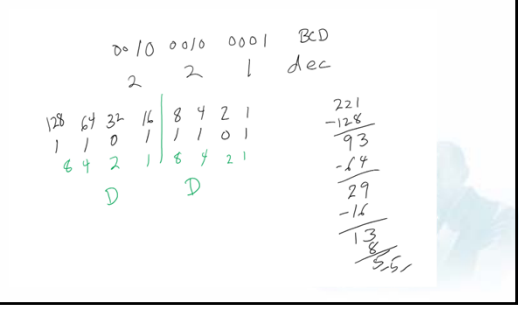
Worked Example

BCD 0010 0010 0001 to Dec, Binary, and Hex



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