Digital Logic

Lecture 1

2nd Stage

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Fall 2022

Topics covered

- ✧ Introduction
- ✧ Digital and Analog
- ✧ Advantages of Digital Techniques
- ✧ Digital Circuits
- ✧ Number Systems
- ✧ Conversion Among Bases

Digital Logic

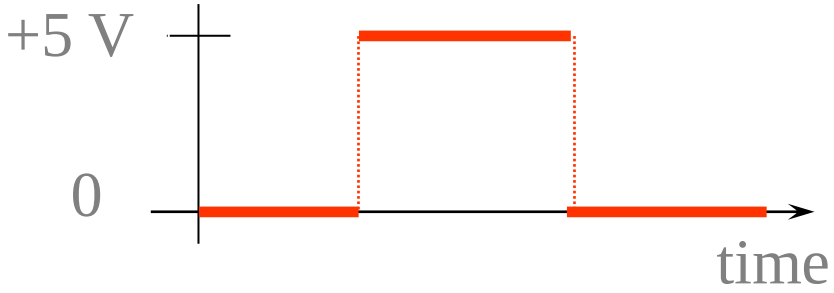
✧Definition of Digital Logic

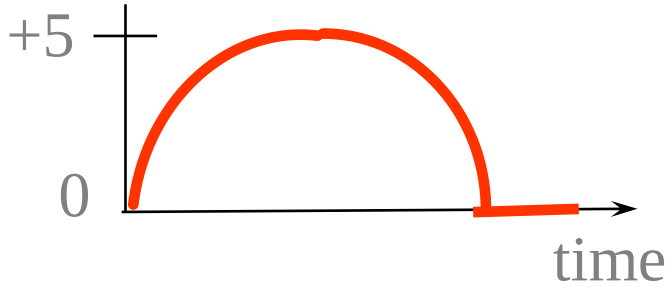
- Digital logic consists of binary variables and a set of logical operations.

- The variables are designated by letters of the alphabet, such as *A*, *B*, *C*, *x*, *y*, *z*, etc., with each variable having two and only two distinct possible values: 1 and 0,

Digital and Analog

Digital vs. Analog Waveforms





Digital:
only assumes discrete values

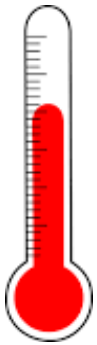
Analog:
values vary over a broad range continuously

Advantages of Digital Techniques

- Digital systems are generally easier to design.
- Information storage is easy.
- Accuracy and precision are greater.
- Operation can be programmed.
- Digital circuits are less effected by noise.
- More digital circuitry can be fabricated on IC chips.

Limitations of Digital Techniques

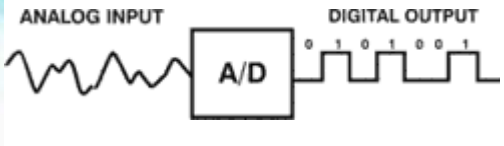
- *The real world is mainly analog*.
- To deal with analog inputs, three steps must be followed:
  - Convert the real-world analog inputs to digital form (analog-to-digital converter, ADC)
  - Process (operate on) the digital information
  - Convert the digital output back to real-world analog form (digital-to-analog converter, DAC)

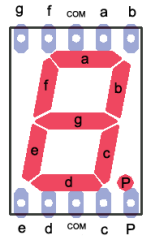


Temperature sensor (analog)

A/D converter

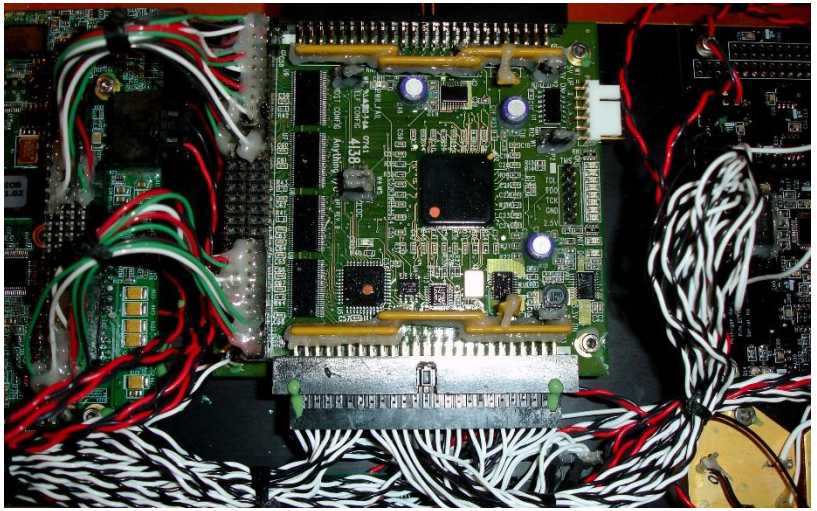
Display





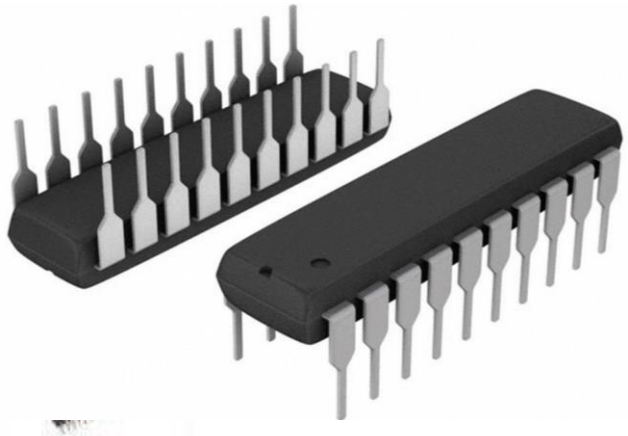
Digital Circuits

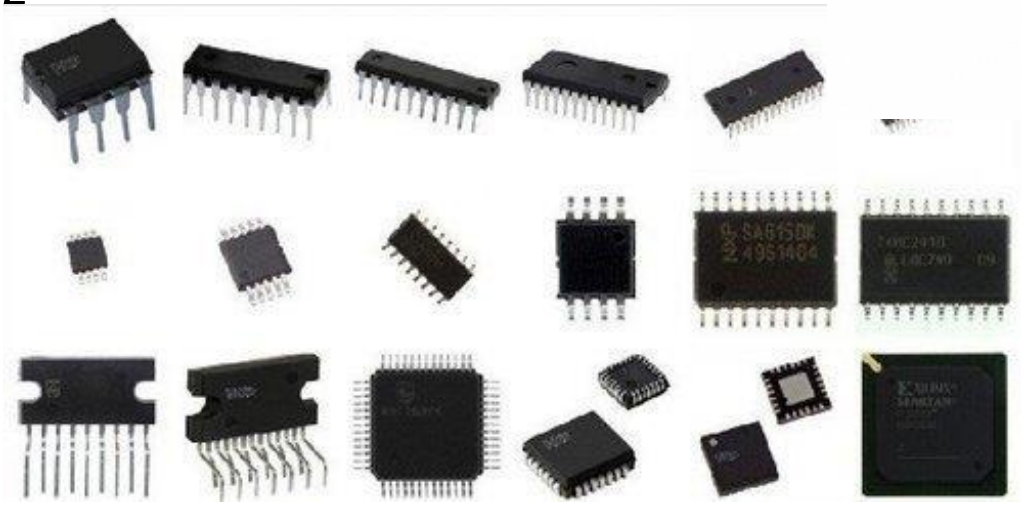
- *Digital circuits are designed to produce output voltages that fall within the prescribed 0 and 1 voltage ranges.*
- *A digital circuit responds to an input's binary level (0 or 1) and not to its actual voltage.*
- *The manner in which a digital circuit responds to an input is referred to as the circuit's logic.*
- *Each type of digital circuit obeys a certain set of logic rules.*
- *For this reason, digital circuits are also called logic circuits.*



Digital Integrated Circuits

- *Almost all of the digital circuits used in modern digital systems are integrated circuits (ICs).*
- *Several fabrication technologies are used:*
  - *TTL*
  - *CMOS*
  - *NMOS*
  - *ECL*





Common Number Systems

System	Base	Symbols
Decimal	10	0, 1, … 9
Binary	2	0, 1
Octal	8	0, 1, … 7
Hexa-decimal	16	0, 1, … 9, A, B, … F

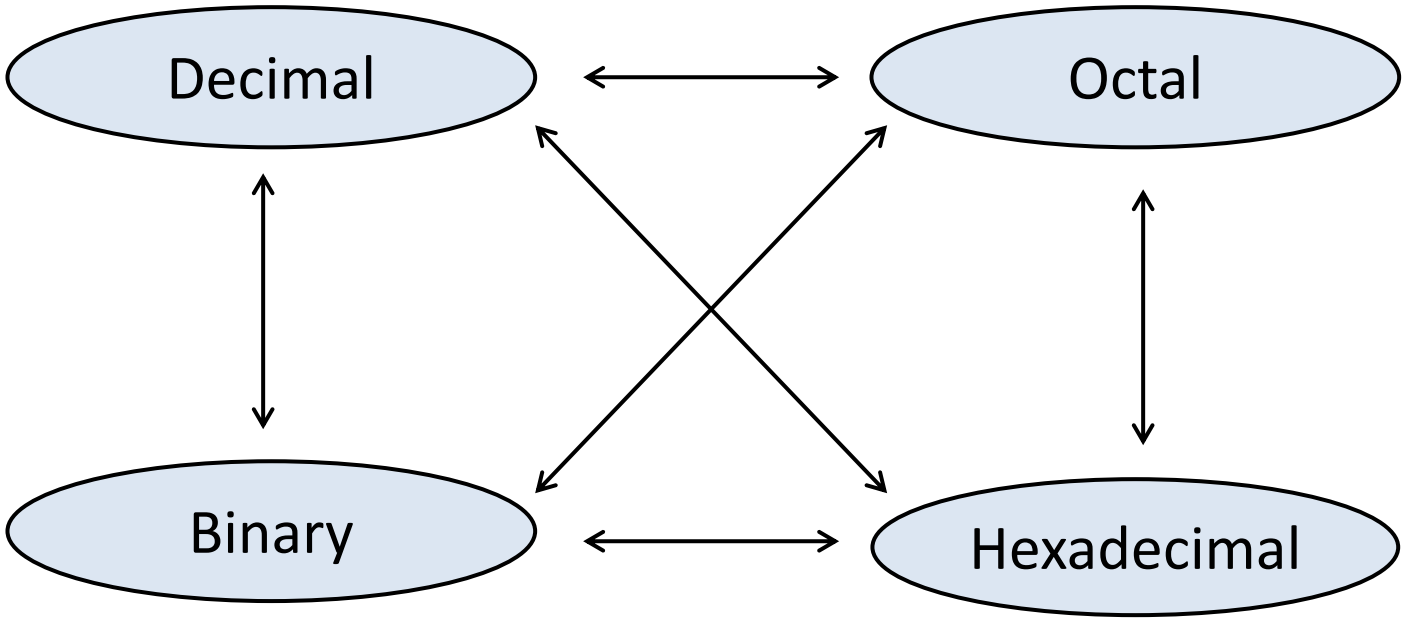
Common Number Systems

Decimal	Binary	Octal	Hexa-decimal
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7

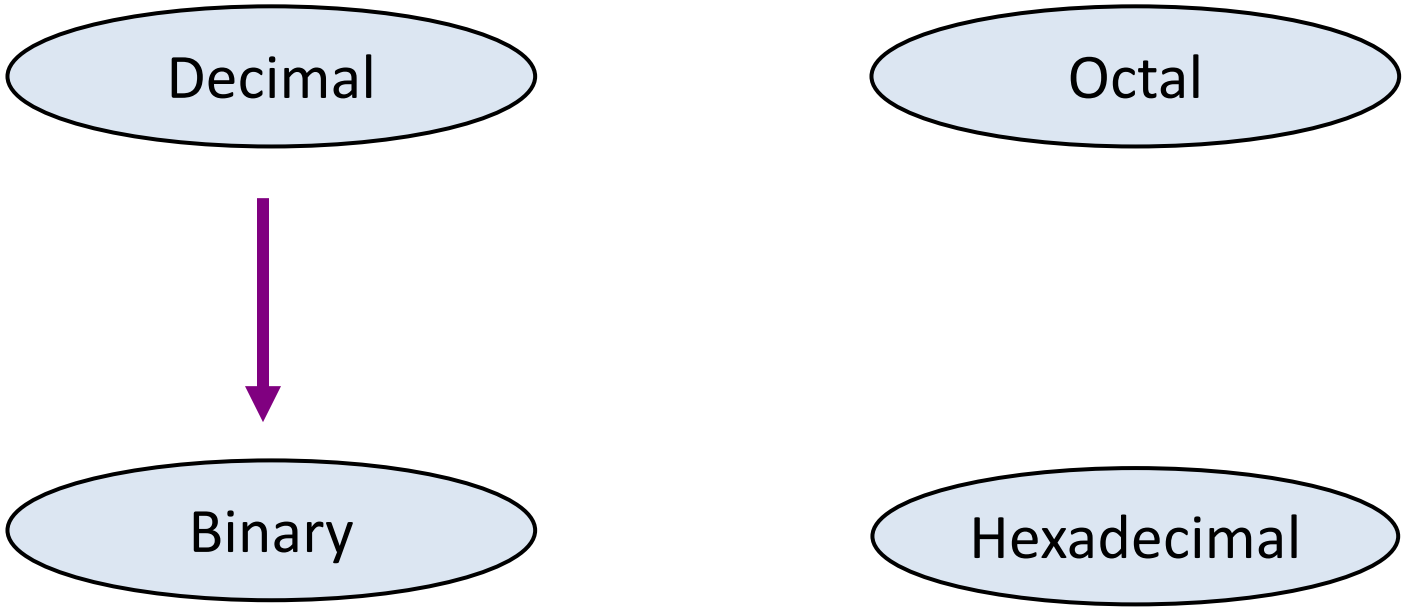
Common Number Systems

Decimal	Binary	Octal	Hexa-decimal
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

Conversion among bases

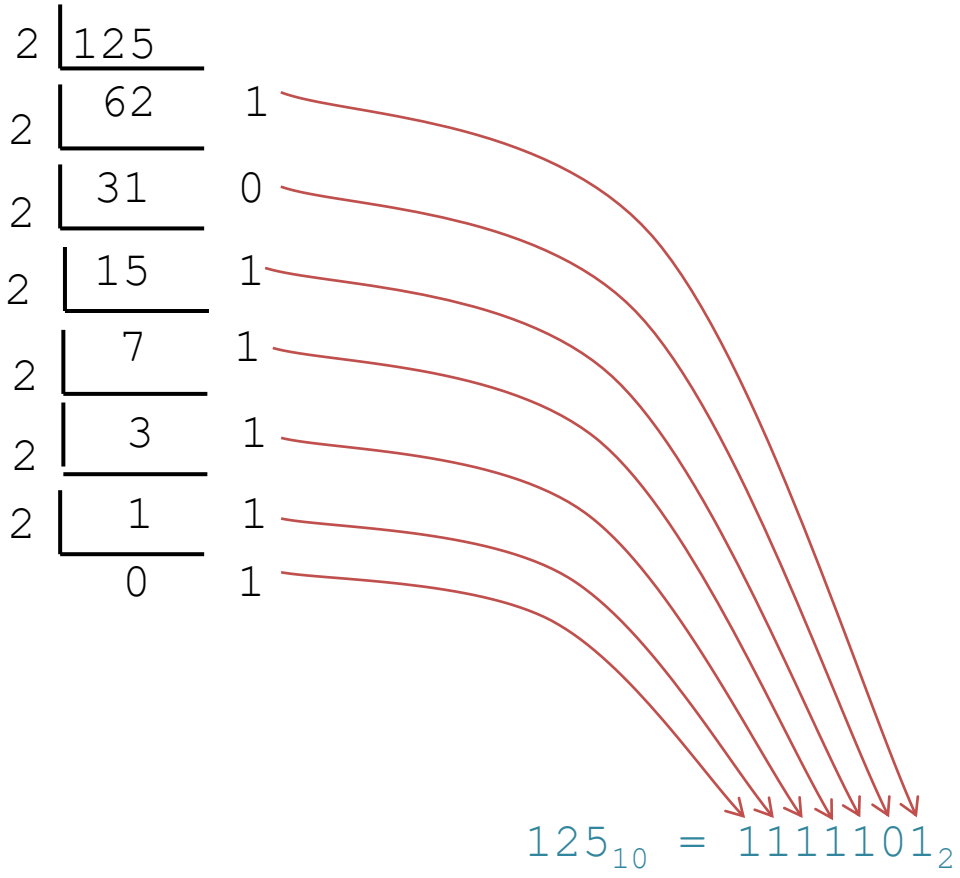


Decimal to Binary

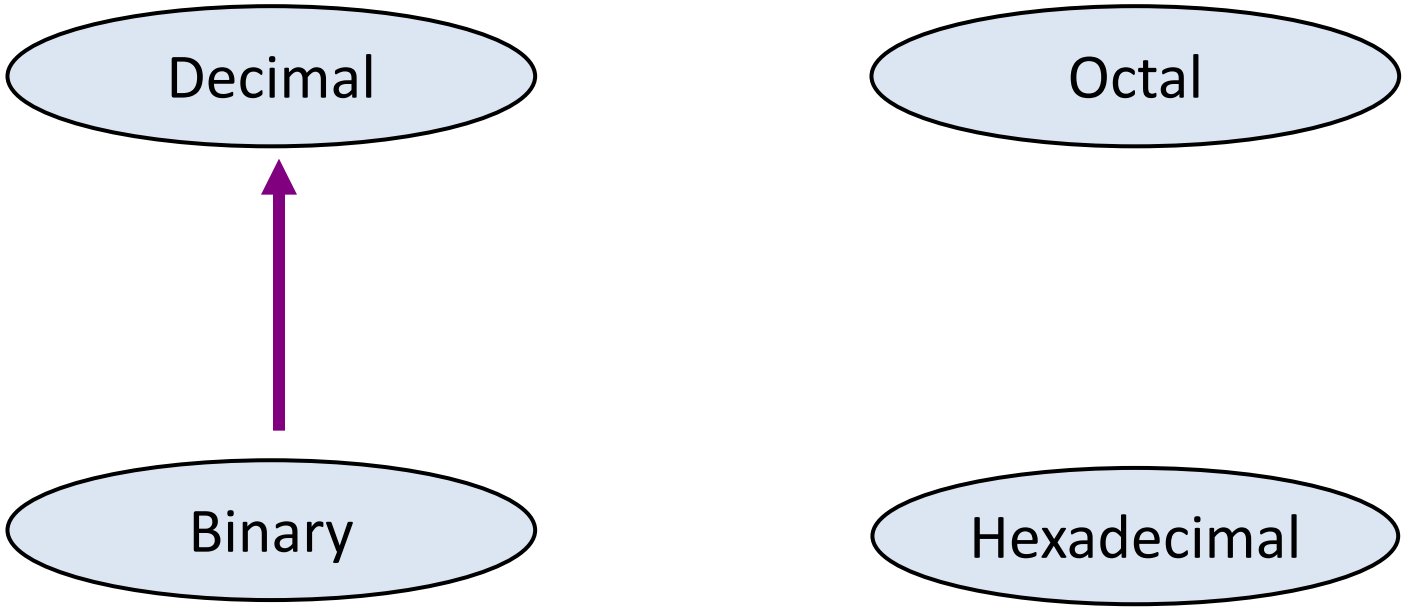


Decimal to Binary

$125_{10} = (?)_2$



Binary to Decimal



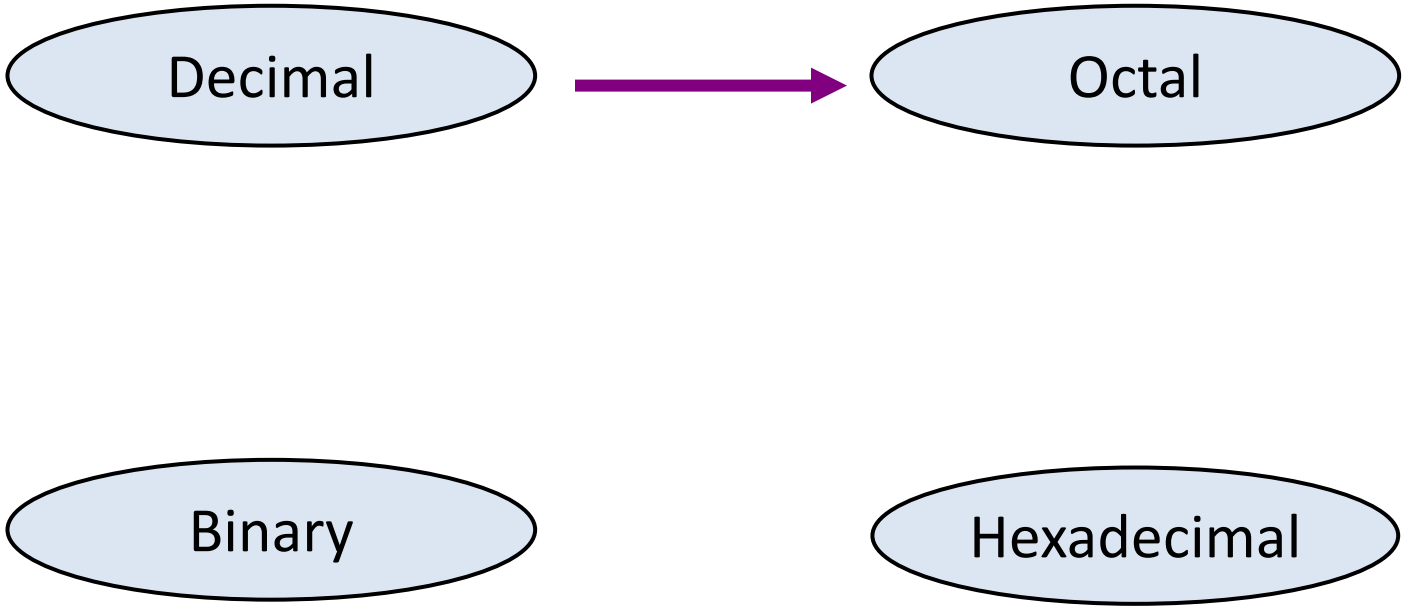
Binary to Decimal

$101011_2 = (?)_{10}$

$101011_2 \Rightarrow$

$$
\begin{aligned}
1 \times 2^0 &= 1 \\
1 \times 2^1 &= 2 \\
0 \times 2^2 &= 0 \\
1 \times 2^3 &= 8 \\
0 \times 2^4 &= 0 \\
1 \times 2^5 &= 32 \\
&\hline \\
&43_{10}
\end{aligned}
$$

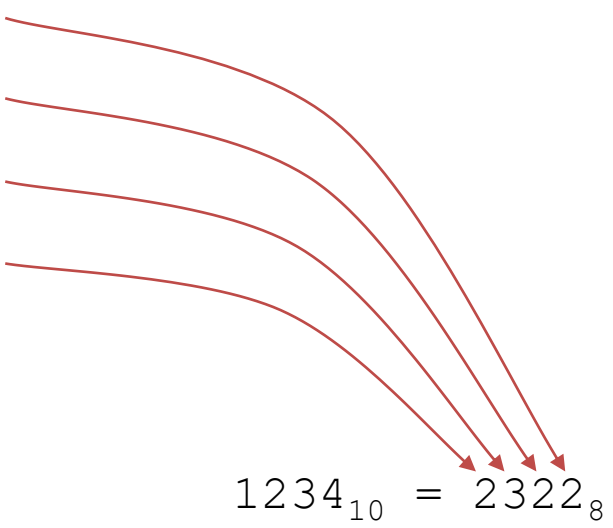
Decimal to Octal



Decimal to Octal

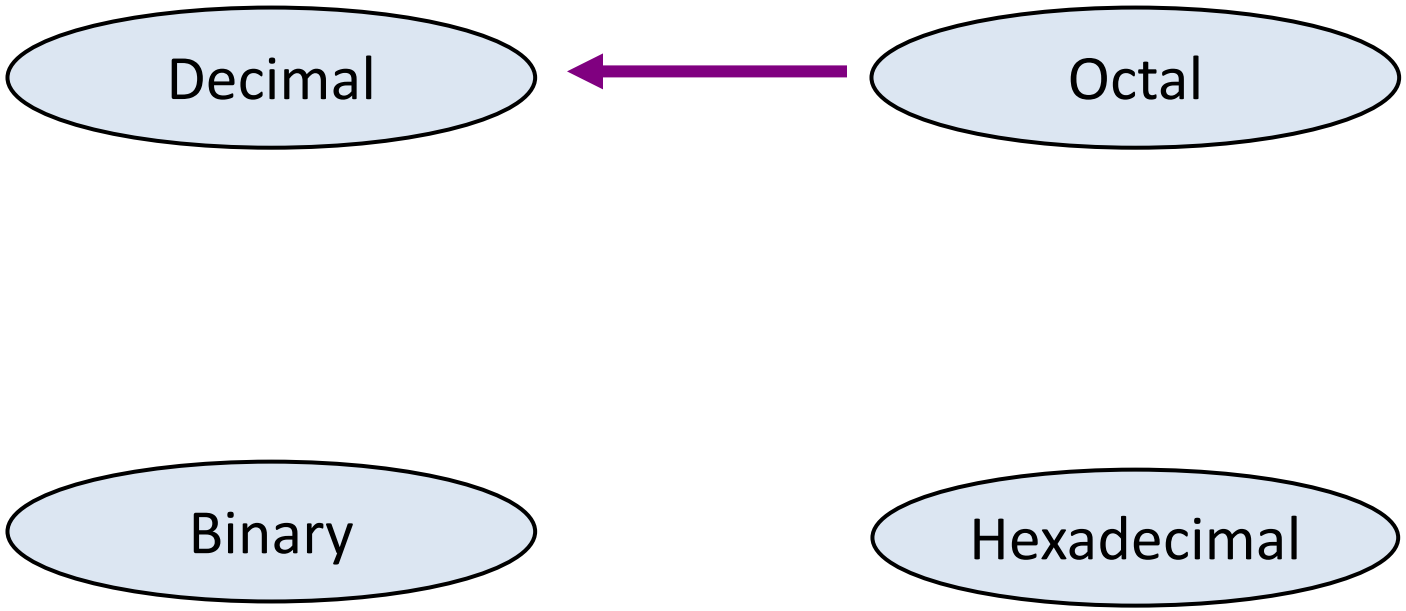
$1234_{10} = (?)_8$

8	1234	
8	154	2
8	19	2
8	2	3
	0	2



$1234_{10} = 2322_8$

Octal to Decimal



Octal to Decimal

$724_8 = (?)_{10}$

$724_8 \Rightarrow$

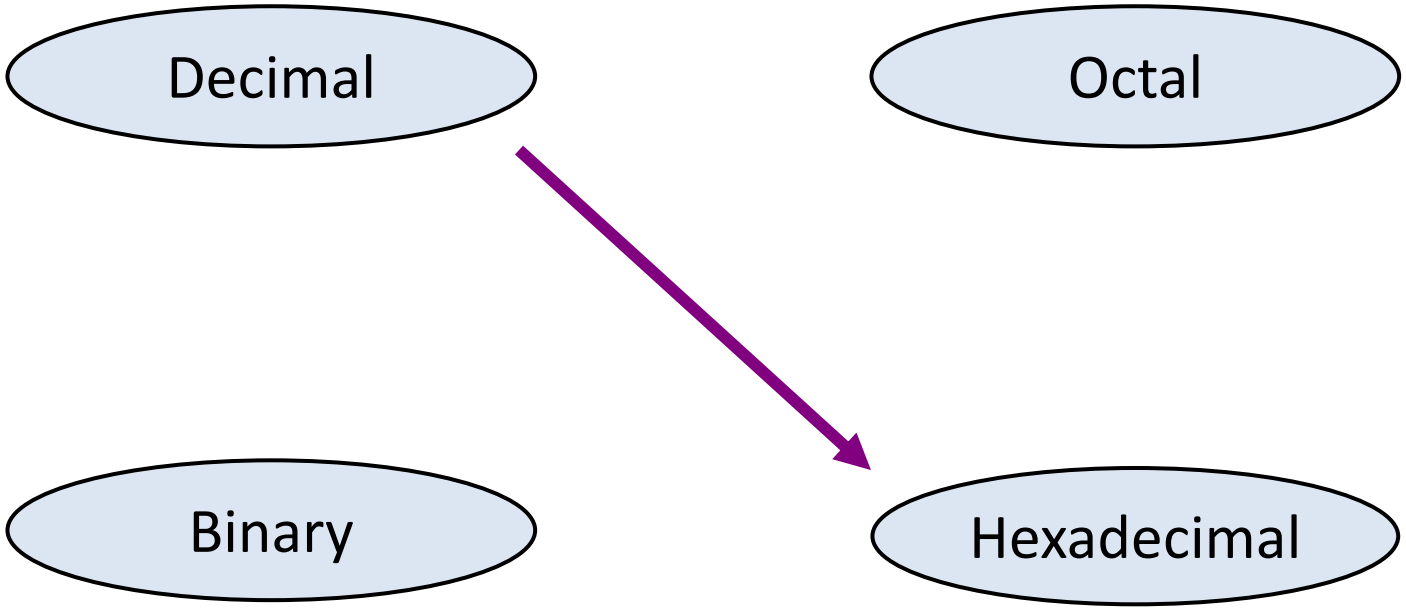
$4 \times 8^0 = 4$

$2 \times 8^1 = 16$

$7 \times 8^2 = 448$

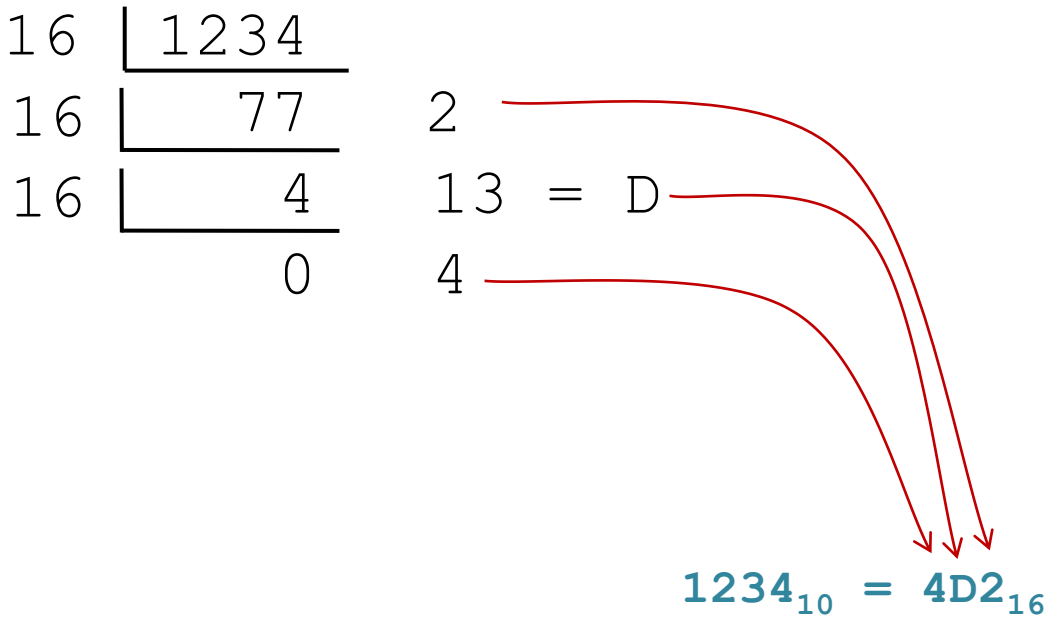
468_{10}

Decimal to Hexadecimal

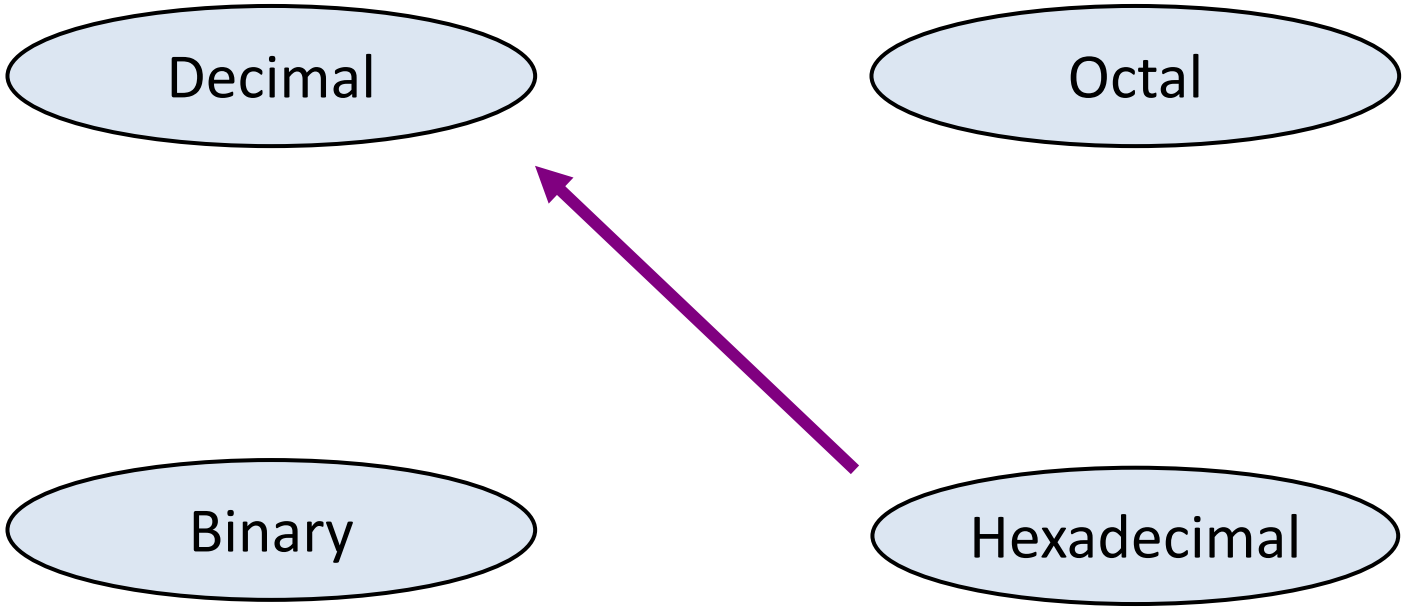


Decimal to Hexadecimal

$1234_{10} = (?)_{16}$



Hexadecimal to Decimal



Hexadecimal to Decimal

$ABC_{16} = ()_{10}$

$ABC_{16} \Rightarrow$

$C \times 16^0 = 12 \times 1 = 12$

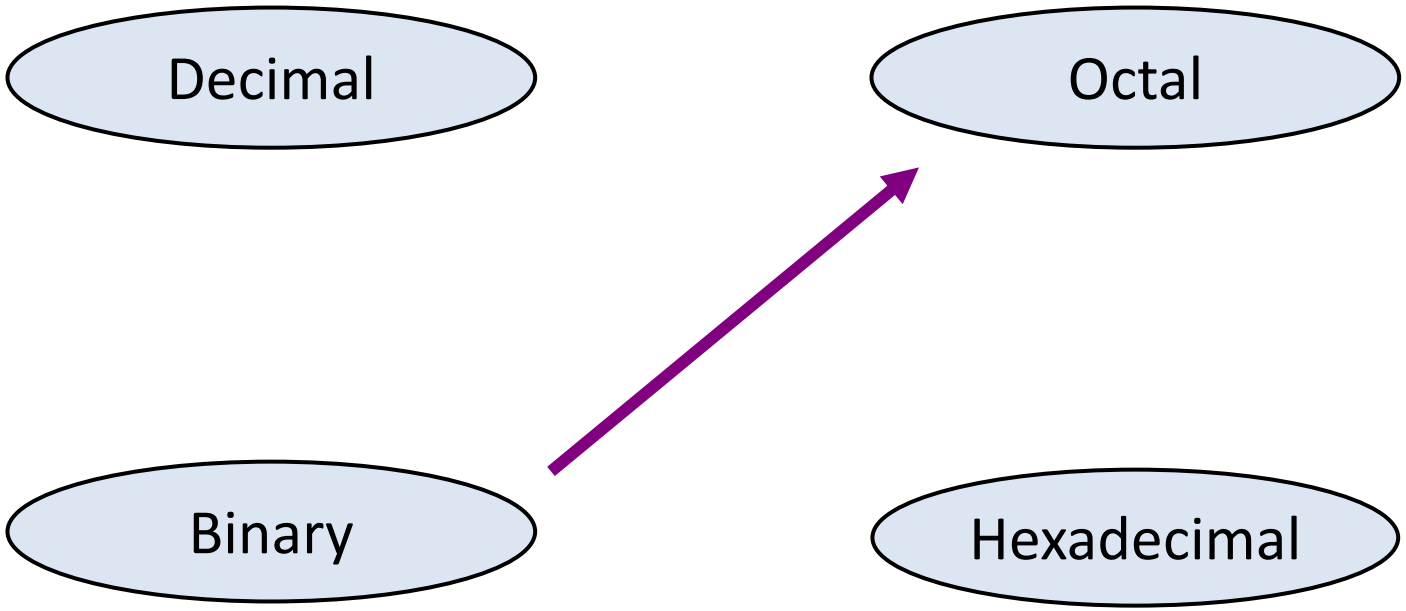
$B \times 16^1 = 11 \times 16 = 176$

$A \times 16^2 = 10 \times 256 = 2560$

$+$

2748_{10}

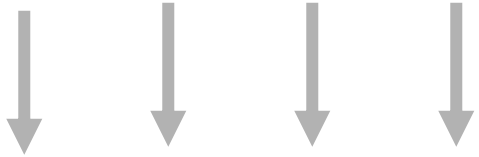
Binary to Octal



Binary to Octal

$1011010111_2 = (?)_8$

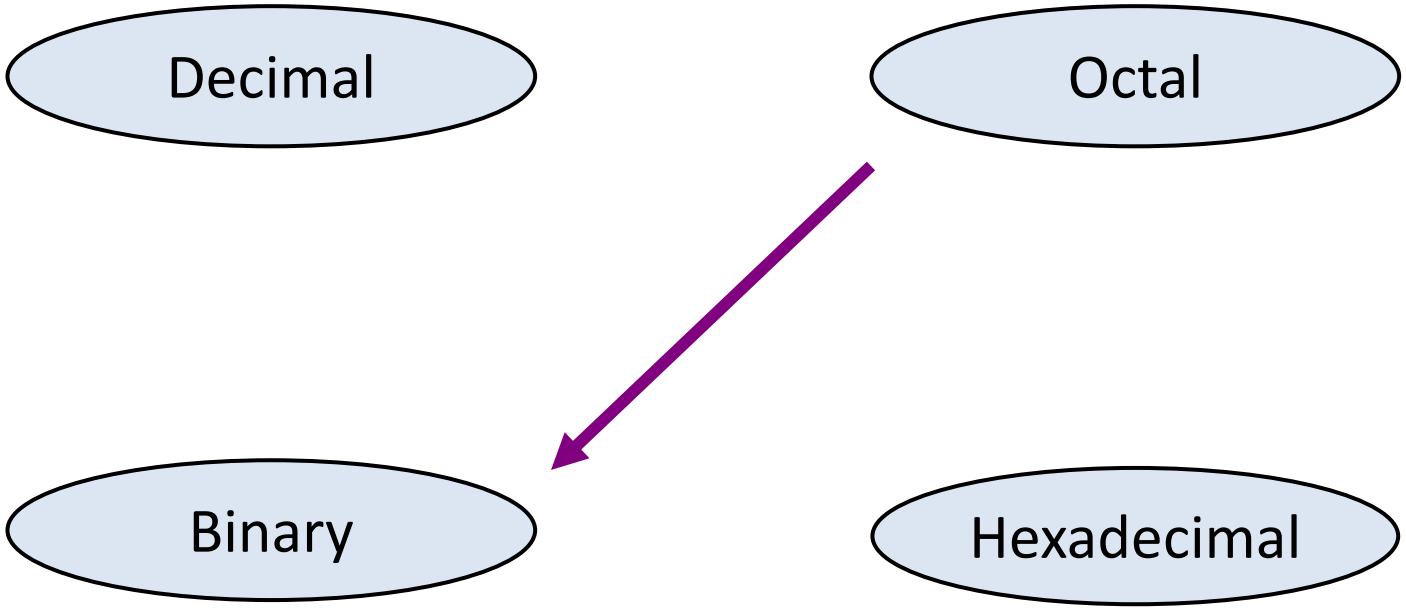
1 011 010 111



1 3 2 7

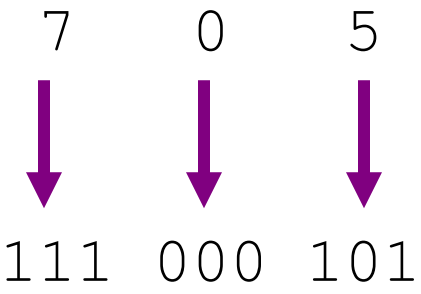
$1011010111_2 = 1327_8$

Octal to Binary



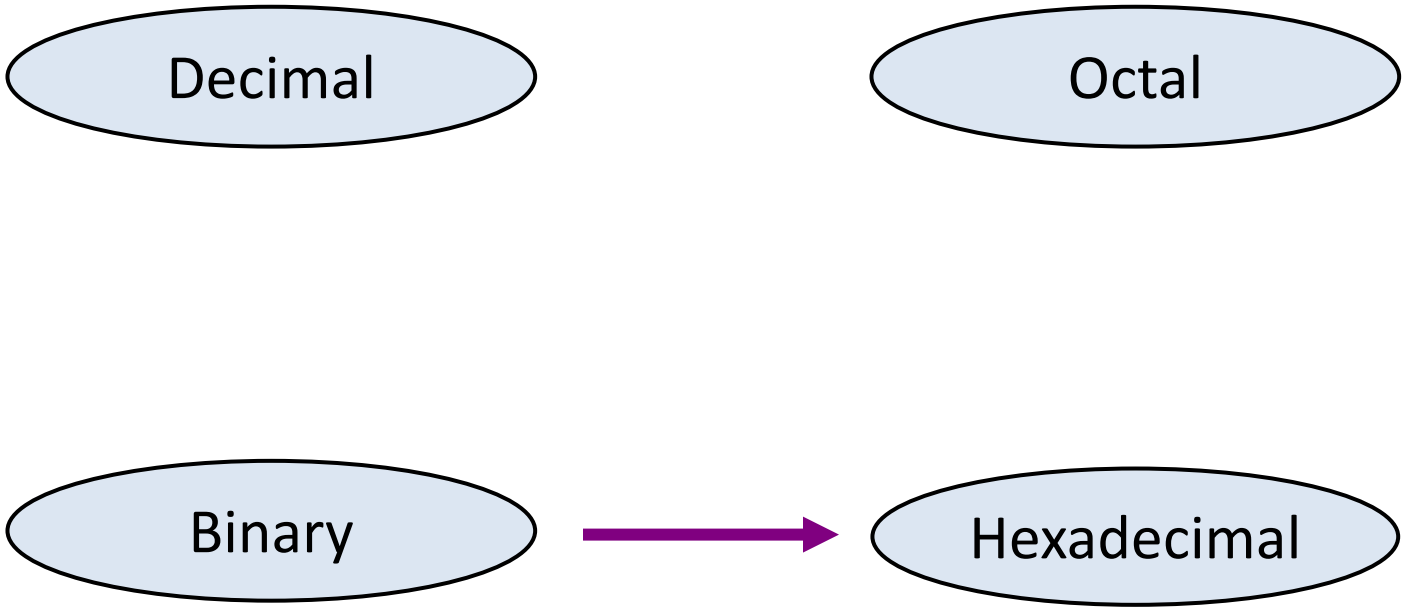
Octal to Binary

$705_8 = (?)_2$



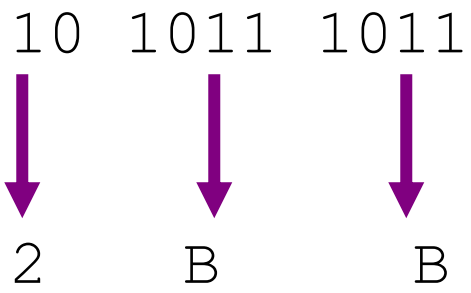
$705_8 = 111000101_2$

Binary to Hexadecimal



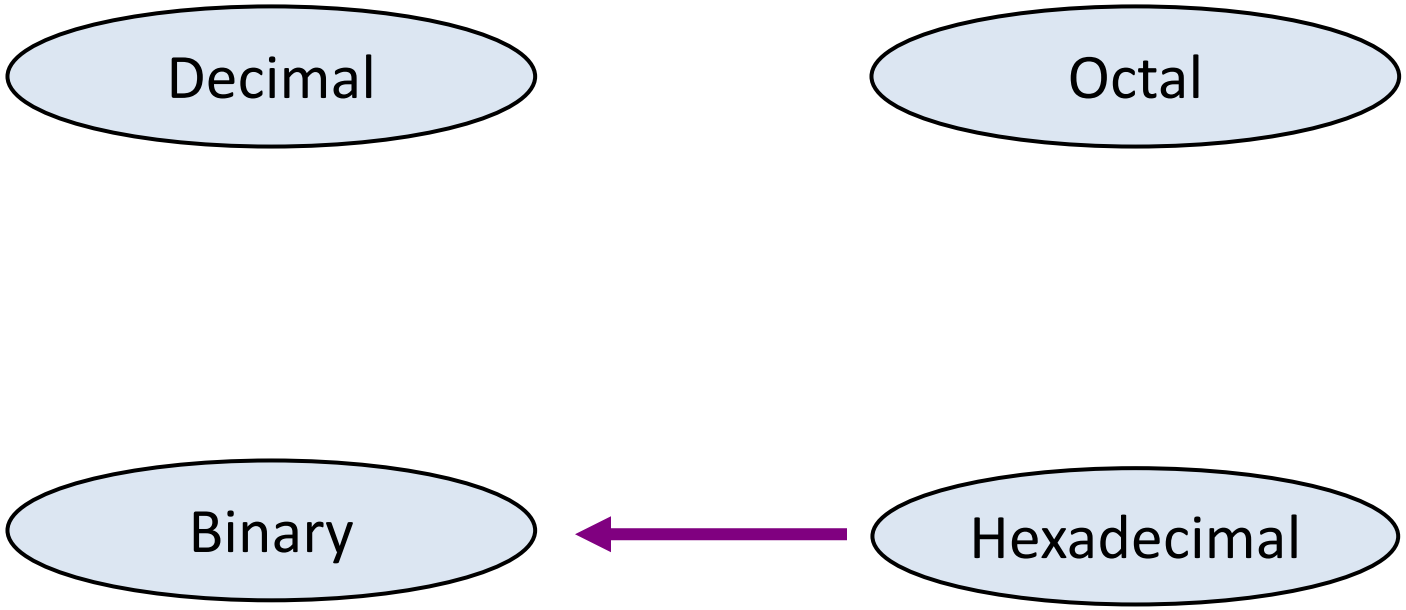
Binary to Hexadecimal

$1010111011_2 = (?)_{16}$



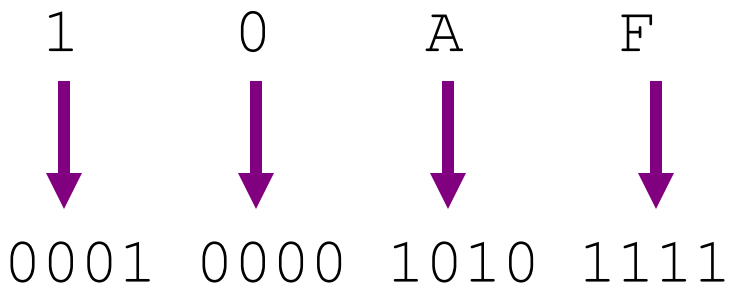
$1010111011_2 = 2BB_{16}$

Hexadecimal to Binary



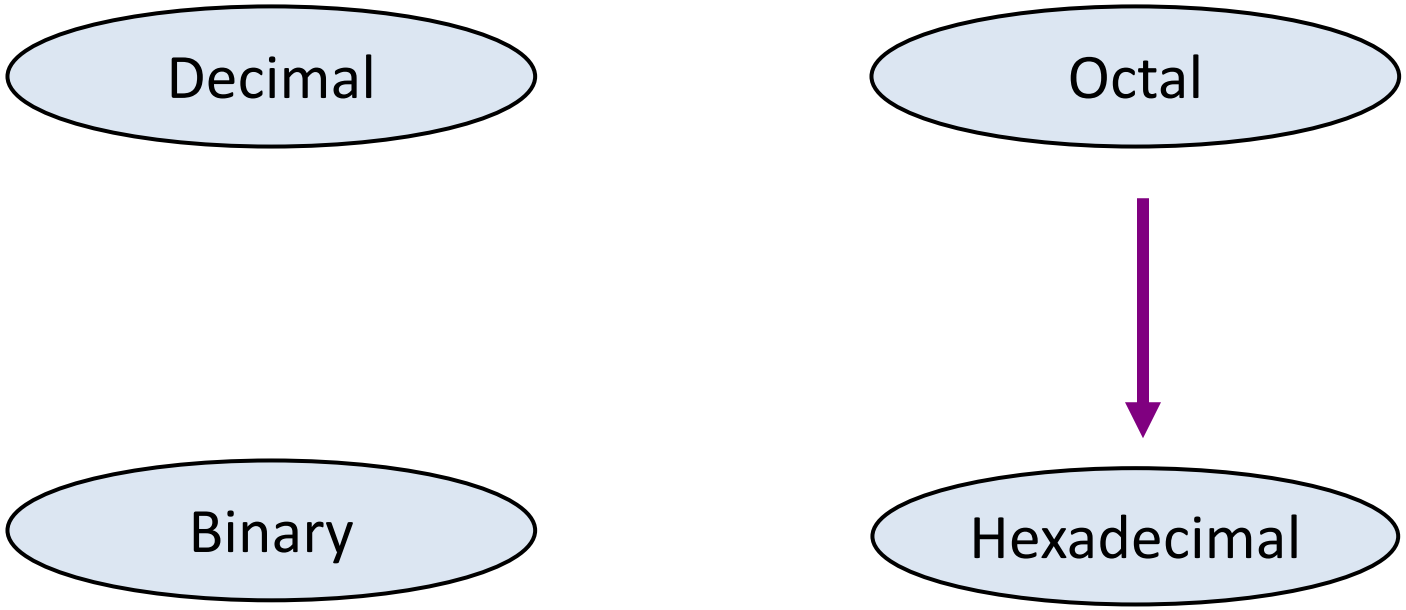
Hexadecimal to Binary

$10AF_{16} = (?)_2$



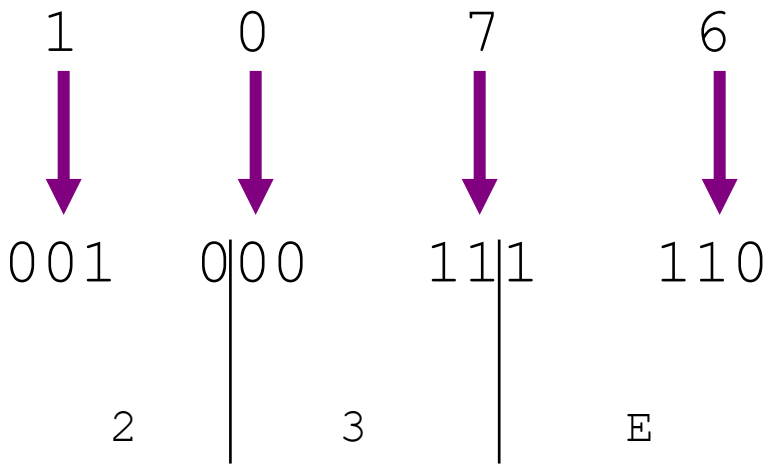
$10AF_{16} = 0001000010101111_2$

Octal to Hexadecimal



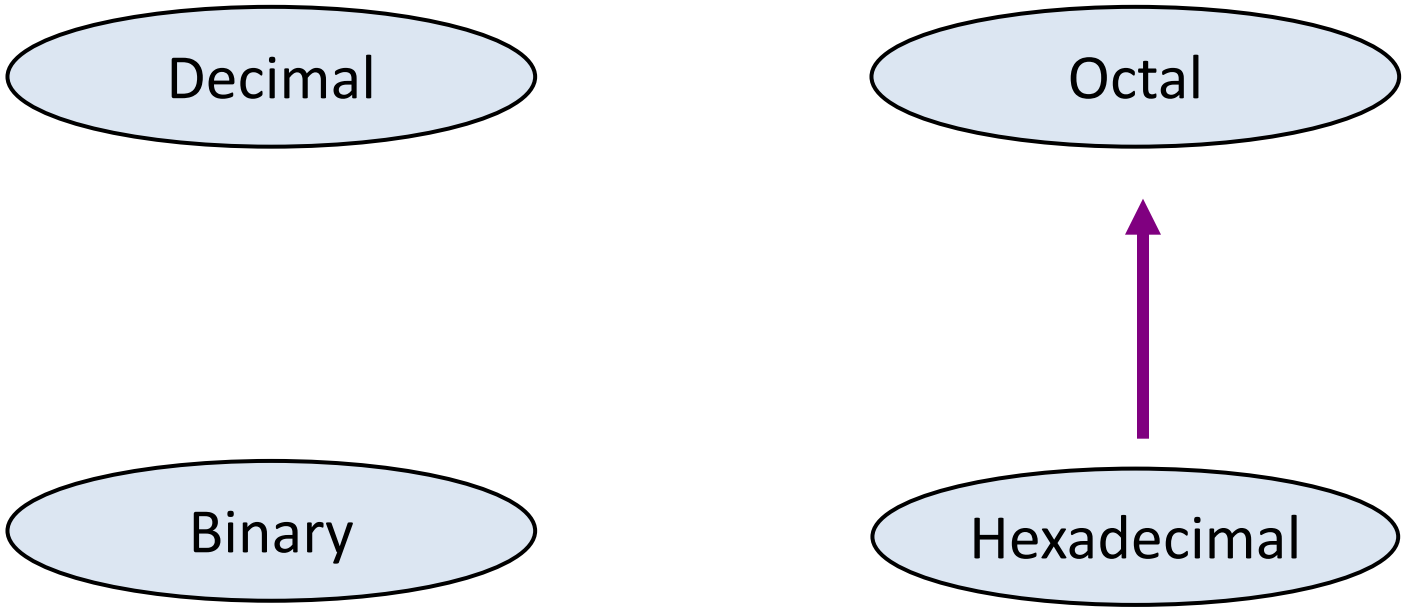
Octal to Hexadecimal

$1076_8 = (?)_{16}$



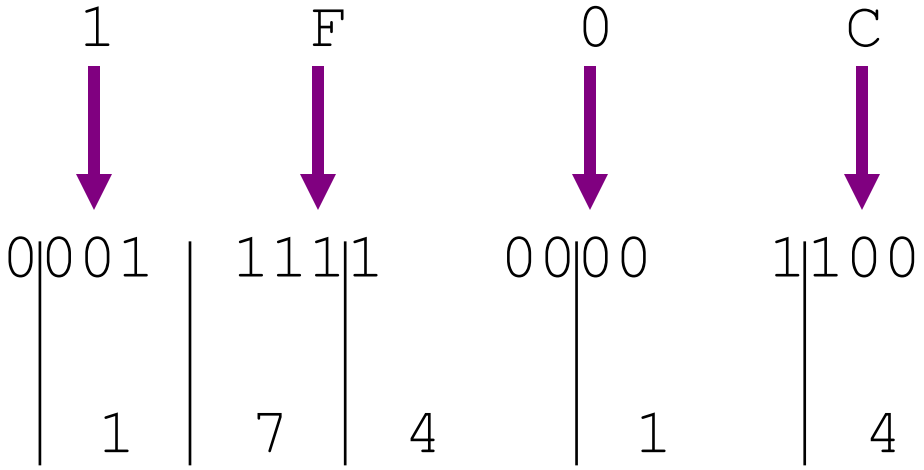
$1076_8 = 23E_{16}$

Hexadecimal to Octal



Hexadecimal to Octal

$1F0C_{16} = (?)_8$



$1F0C_{16} = 17414_8$

Homework 1

Convert the following numbers

A) $(CDC)_{16} = (\ ?\ )_{8}$ (show your work)

B) $(7165)_{8} = (\ ?\ )_{16}$ (show your work)

C) $(1101\ 0110)_{2} = (\ ?\ )_{10}$ (show your work)

D) $(984)_{10} = (\ ?\ )_{2}$ (show your work)

Deadline: October 7, 2022 @ 11:59 PM

Number Systems

Continues…..