

Gear up for  
**COMPUTER  
SCIENCE**  
**Series**

*Target 80/80*



# NUMBER SYSTEM & CODES

# BINARY NUMBERS

- The binary number system is a positional weighted system.
- The base or radix of this number system is 2.
- The symbols used are 0 and 1.
- A binary digit i.e. 0 or 1, is called a bit.

# DECIMAL NUMBER SYSTEM

- It has 10 symbols or digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). Hence, its base = 10
- The maximum value of a single digit is 9 (one less than the value of the base)
- Each position of a digit represents a specific power of base (10)
- A Decimal number is the sum of the products of the digits and their respective weights.

Eg:

$$23 = 2 \times 10 + 3 \times 1 = 20 + 3$$

- To represent the quantity 23, use 2 to represent the quantity 20 and 3 to represent the quantity three
- The position of the digit in the decimal number indicates the magnitude of the quantity represented and is assigned a weight

# EXAMPLE

*Q. Express the decimal number 568.23 as a sum of the values of each digit.*

$$\begin{aligned}568.23 &= (5 \times 10^2) + (6 \times 10^1) + (8 \times 10^0) + (2 \times 10^{-1}) + (3 \times 10^{-2}) \\&= (5 \times 100) + (6 \times 10) + (8 \times 1) + (2 \times 0.1) + (3 \times 0.01) \\&= 500 + 60 + 8 + 0.2 + 0.03\end{aligned}$$



# OCTAL NUMBER SYSTEM

- Octal number system is composed of eight digits which are 0, 1, 2, 3, 4, 5, 6, 7
- Use the subscript 8 to indicate an octal number

Octal/binary conversion.

Octal Digit	0	1	2	3	4	5	6	7
Binary	000	001	010	011	100	101	110	111

# HEXADECIMAL NUMBER SYSTEM

- **Hexadecimal** number system has a base of sixteen; that is, it is composed of 16 **numeric** and alphabetic **characters**
- Each hexadecimal digit represents a 4-bit binary number

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

# Base/Radix

- ① Decimal Number System  $\rightarrow [10] \rightarrow$  base/radix
- ② Binary  $\rightarrow [2] \rightarrow$  base/radix = 0, 1
- ③ Octal  $\rightarrow [8] -$  base/radix = 0, 1, 2, 3, 4, 5, 6, 7
- ④ Hexadecimal  $\rightarrow [16] -$  II = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- ⑤ Any base  $\rightarrow$

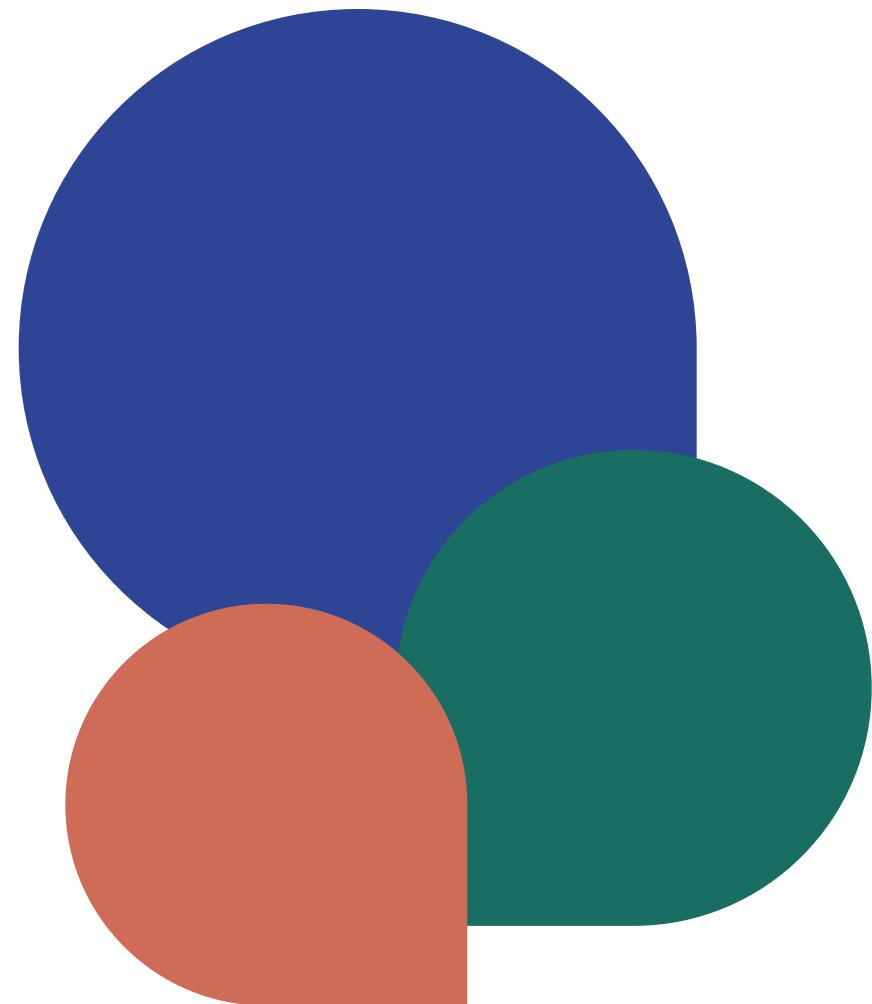
Base/radix tell about no. of symbolic representation in it.

# CONVERSIONS

This topic includes converting a number from one base to another.

# Conversion to Decimal

- Binary to Decimal
- Octal to Decimal
- Hexadecimal to Decimal



# BINARY TO DECIMAL CONVERSION

- Binary numbers may be converted to their decimal equivalents by the positional weights method.
- In this method, each binary digit of the number is multiplied by its position weight and the product terms are added to obtain the decimal number.
- Add the weights of all 1's in a binary number to get the decimal value

$2^3$	$2^2$	$2^1$	$2^0$	$2^{-1}$	$2^{-2}$	$2^{-3}$	$2^{-4}$
8	4	2	1	0.5	0.25	0.125	0.0625

- Q. Convert the fractional binary number 0.1011 to decimal
  - Determine the weight of each bit that is a 1 and then sum the weights to get the decimal fraction
  - Weight                   $2^{-1}$                    $2^{-2}$                    $2^{-3}$                    $2^{-4}$
  - Binary no:    0. 1      0                  1                  1
  - 0.1011                   $=2^{-1} + 2^{-2} + 2^{-3} + 2^{-4}$
  - =                   $0.5 + 0.125 + 0.0625$
  - =                   $0.6875$

# Practise Problems

## Problem 1

- Convert binary to decimal

**1101001.1011**

# Solution

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$$(1101001.1011)_2 \rightarrow (?)_{10}$$
$$2^6 \times 1 + 2^5 \times 1 + 2^3 \times 1 + 2^0 \times 1$$
$$= 64 + 32 + 8 + 1$$
$$= 96 + 9 = \underline{105}$$

$\begin{array}{r} 1 \ 0 \ 11 \\ \times 0.50000 \\ \hline 0.25000 \\ \times 0.25000 \\ \hline 0.12500 \\ \times 0.12500 \\ \hline 0.0625 \\ \hline 0.5000 \\ \times 0.1250 \\ \hline 0.1250 \\ \times 0.0625 \\ \hline 0.0625 \\ \hline 0.6875 \\ \hline 105.6875 \end{array}$

# Practise Problems

## Problem 2

- Convert binary to decimal

**1001101.1110**

$$\begin{aligned}(1001101.1110)_2 &= (1 \times 2^6) + (0 \times 2^5) + (0 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + \\(0 \times 2^1) + (1 \times 2^0) + (1 \times 2^{-1}) + (1 \times 2^{-2}) + (1 \times 2^{-3}) + (0 \times 2^{-4}) = \\(77.875)_{10}\end{aligned}$$

# OCTAL TO DECIMAL CONVERSION

To convert an octal number (base-8) to the decimal (base-10) number system, we need to use octal place value to add the base-10 value of each digit.

In the octal place value system, each time you move a place to the left, the value increases eight-fold.

In octal, the digit values go from zero to seven; numbers 8 and 9 are not allowed!



## Convert 3250 from octal into decimal.

Step 1) Write down the place value of each digit.

$8^3$	$8^2$	$8^1$	$8^0$
512	64	8	1
3	2	5	0

Step 2) Add up the place value of each digit.

$$512 \times 3 + 64 \times 2 + 8 \times 5 + 1 \times 0$$

$$1536 + 128 + 40 + 0 = 1704$$

---

So 3250 in octal is equal to 1704.

# Practise Problems

## Problem 1

- Convert octal to decimal

**4761.25**

# Solution

$$(4761.25)_8 \rightarrow (?)_{10}$$

$$\begin{aligned} & 8^3 \times 4 + 8^2 \times 7 + 8^1 \times 6 + 8 \\ = & 2545 \end{aligned}$$

$$\begin{aligned} & = 8^{-1} \times 2 + 8^{-2} \times 5 \\ & = (0.125 \times 2) + (0.0156 \times 5) \end{aligned}$$

$$= 2545.328125$$

# Practise Problems

## Problem 2

- Convert octal to decimal

**1125.00**

$$1125.00 = (1 \times 8^3) + (1 \times 8^2) + (2 \times 8^1) + \\ (5 \times 8^0) + (0 \times 8^{-1}) + (0 \times 8^{-2}) = 597$$

# HEXADECIMAL TO DECIMAL CONVERSION

To convert a hexadecimal number (base-16) to the decimal (base-10) number system, we need to use hexadecimal place value to add the base-16 value of each digit.

In the hexadecimal place value system, each time you move a place to the left, the value increases by a factor of 16.

In hexadecimal, the digit values go from zero to 15, with the letters A, B, C, D, E and F representing the numbers 10, 11, 12, 13, 14 and 15 respectively.



## Convert 2c7 from hexadecimal to decimal.

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Step 1) Write down the place value of each digit.

$16^2$	$16^1$	$16^0$
256	16	1
2	12	7

Step 2) Add up the place value of each digit.

$$256 \times 2 + 16 \times c + 1 \times 7$$

$$= 512 + 192 + 7 = 711$$

---

**So 2c7 in hexadecimal is equal to 711 in decimal.**

---

Or we could say  $(2c7)_{16} = (711)_{10}$

# Practise Problems

## Problem 1

- Convert hexadecimal to decimal

**12AF**

$$\begin{aligned}(12AF)_{16} &= (1 \times 16^3) + (2 \times 16^2) + \\(10 \times 16^1) + (15 \times 16^0) &= (4783)_{10}\end{aligned}$$

# Practise Problems

## Problem 2

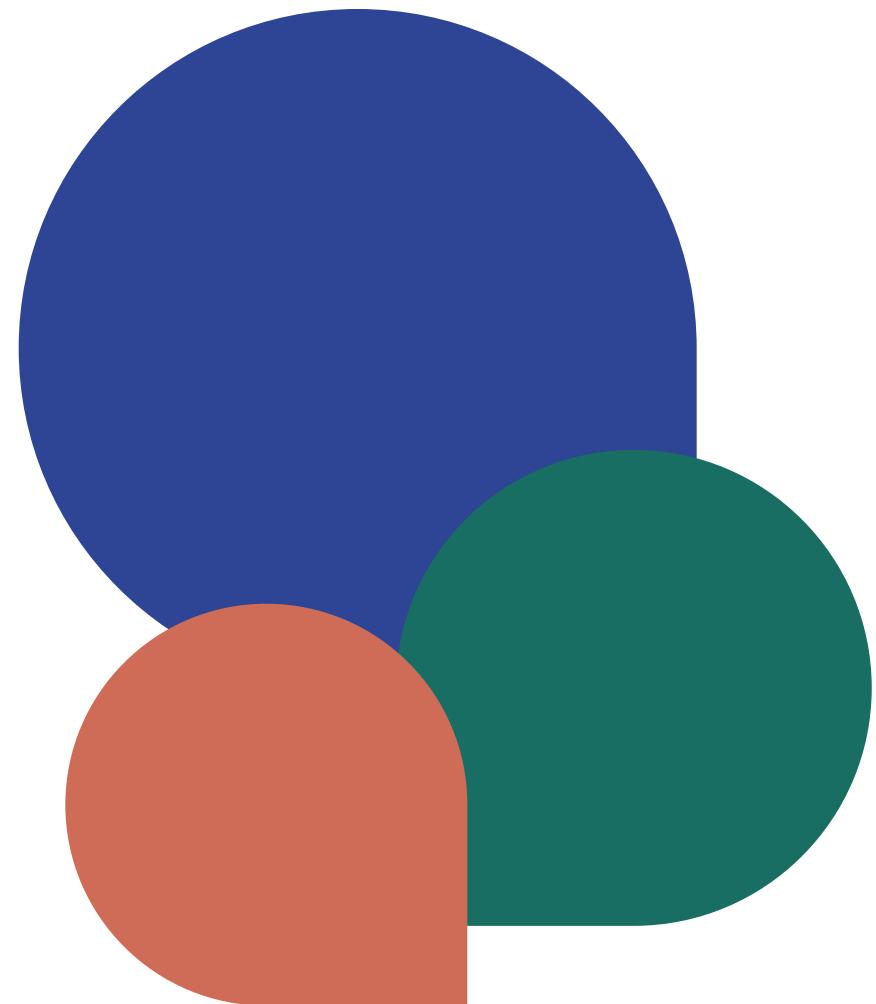
- Convert hexadecimal to decimal

**1A25.2**

$$(1A25.2)_{16} = (1 \times 16^3) + (10 \times 16^2) + (2 \times 16^1) + (5 \times 16^0) + (2 \times 16^{-1}) = (6693.125)_{10}$$

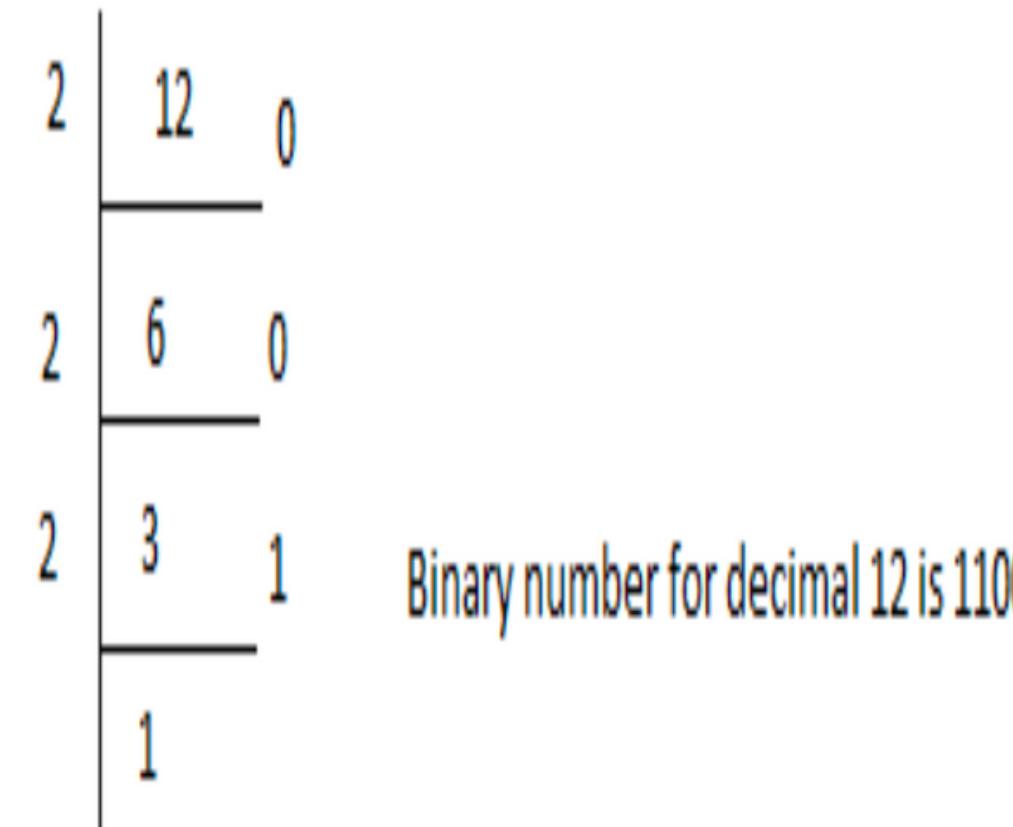
# Conversion to BINARY

- Decimal to Binary
- Octal to Binary
- Hexadecimal to Binary



# DECIMAL TO BINARY CONVERSION

- It's a systematic method
- To convert a decimal number to binary number, begin by dividing the number by 2, then divide each resulting quotient by 2 until there is a 0 whole-number quotient.
- The remainders generated by each division form the binary number, first remainder to be produced is the LSB and the last remainder produced is the MSB



# Converting Decimal Fractions to binary

- Deals with fractional conversions
- MSB is 0.5, which is  $2^{-1}$  and by halving any weight, the next lower weight is obtained which is 0.5, 0.25, 0.125, 0.0625

## **Repeated Multiplication by 2**

- Decimal fractions can be converted to binary by repeated multiplication by 2
- To convert a decimal fraction to binary, begin by multiplying the number by 2 and then multiplying each resulting fractional part of the product by 2 until the fractional product is zero or until the desired decimal places is reached.

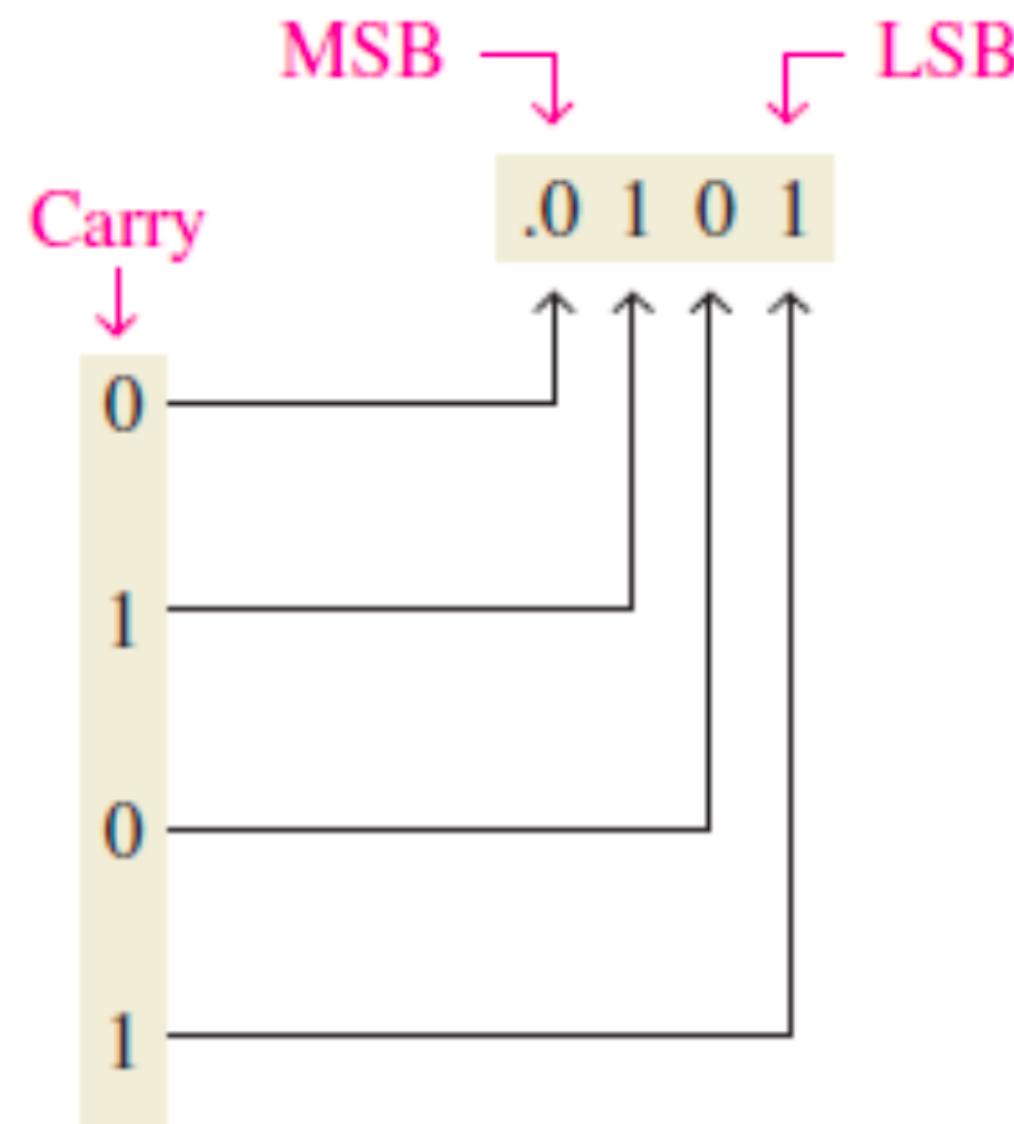
$$0.3125 \times 2 = 0.\underline{6}25$$

$$\downarrow \\ 0.625 \times 2 = 1.\underline{2}5$$

$$\downarrow \\ 0.25 \times 2 = 0.\underline{5}0$$

$$\downarrow \\ 0.50 \times 2 = 1.\underline{00}$$

Continue to the desired number of decimal places — or stop when the fractional part is all zeros.



# Practise Problems

## Problem 1

- Convert decimal to binary conversion

**345.125**

# SOLUTION

101011001.001

# OCTAL TO BINARY CONVERSION

- To convert an octal number to a binary number, simply replace each octal digit with the appropriate three bits.

$$\begin{array}{c} 13_8 \\ \downarrow \quad \downarrow \\ 001011 \end{array}$$

# Practise Problems

## Problem 1

- Convert Octal to binary conversion

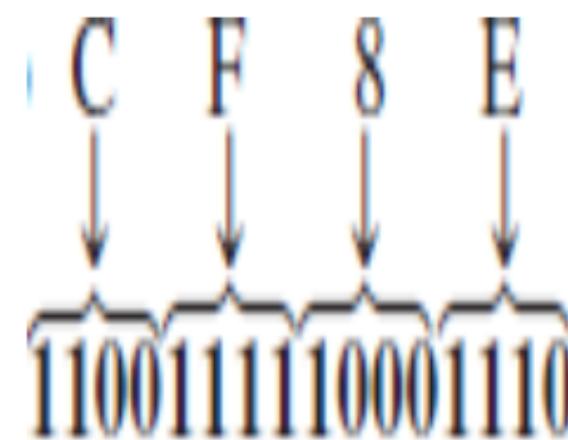
**672.23**

# Solution

**110111010.010011**

# HEXADECIMAL TO BINARY CONVERSION

Replace each hexadecimal symbol with the appropriate four bits.



# Practise Problems

## Problem 1

- Convert Hexadecimal to binary conversion

**B26.F45**

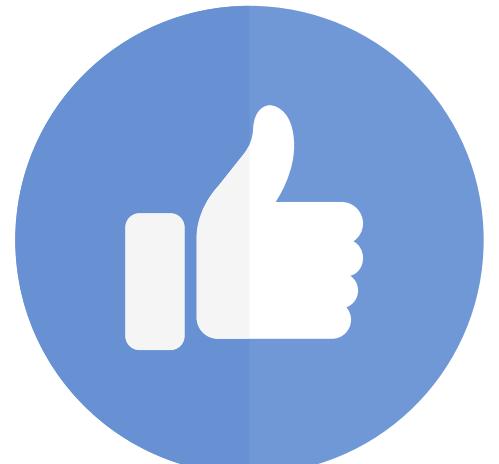
# Solution

**101100100110.111101000101**

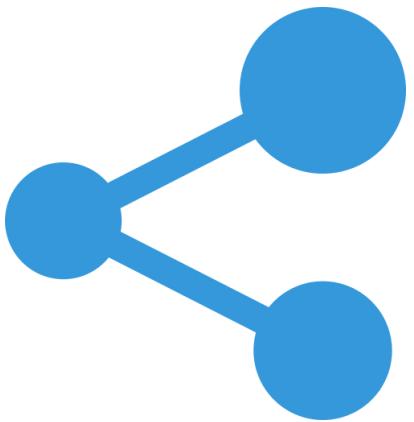
# COMING UP NEXT

- Conversion To Octal
- Conversion to Hexadecimal
- Different radix problems

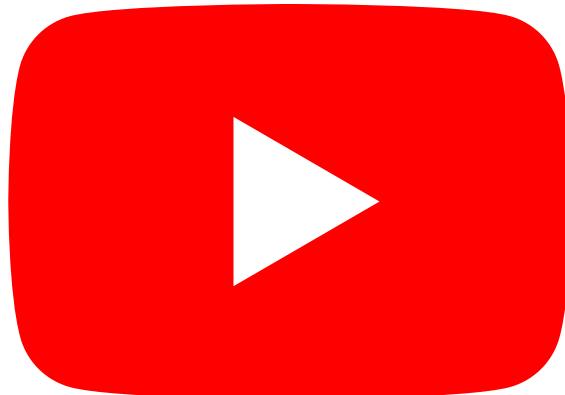
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