

# COMPUTER PROGRAMMING I

-2-

BIL2205

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# Number Systems

2

System	Base	Symbols	Used by humans?	Used in computers?
Decimal	10	0, 1, ... 9	Yes	No
Binary	2	0, 1	No	Yes
Octal	8	0, 1, ... 7	No	No
Hexa-decimal	16	0, 1, ... 9, A, B, ... F	No	Sometimes

# Quantities/Counting

3

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

# Quantities/Counting

4

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

# Quantities/Counting

5

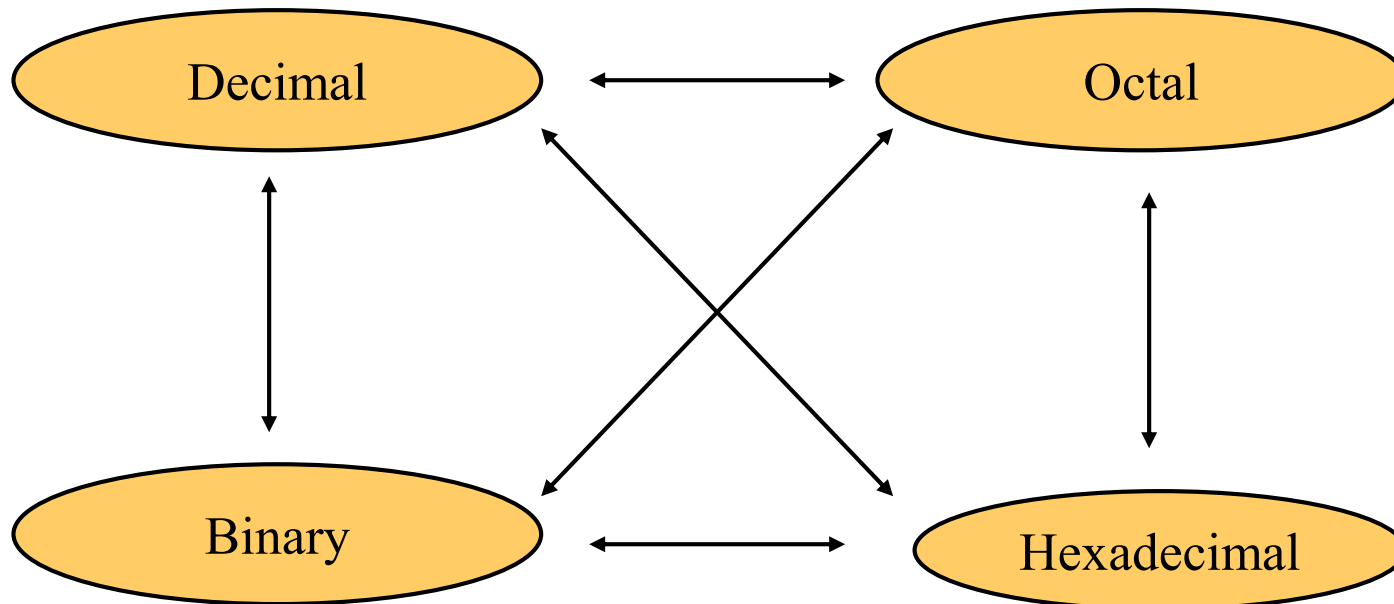
Decimal	Binary	Octal	Hexa- decimal
16	10000	20	10
17	10001	21	11
18	10010	22	12
19	10011	23	13
20	10100	24	14
21	10101	25	15
22	10110	26	16
23	10111	27	17

Etc.

# Conversion Among Bases

6

- The possibilities:



# Quick Example:

7

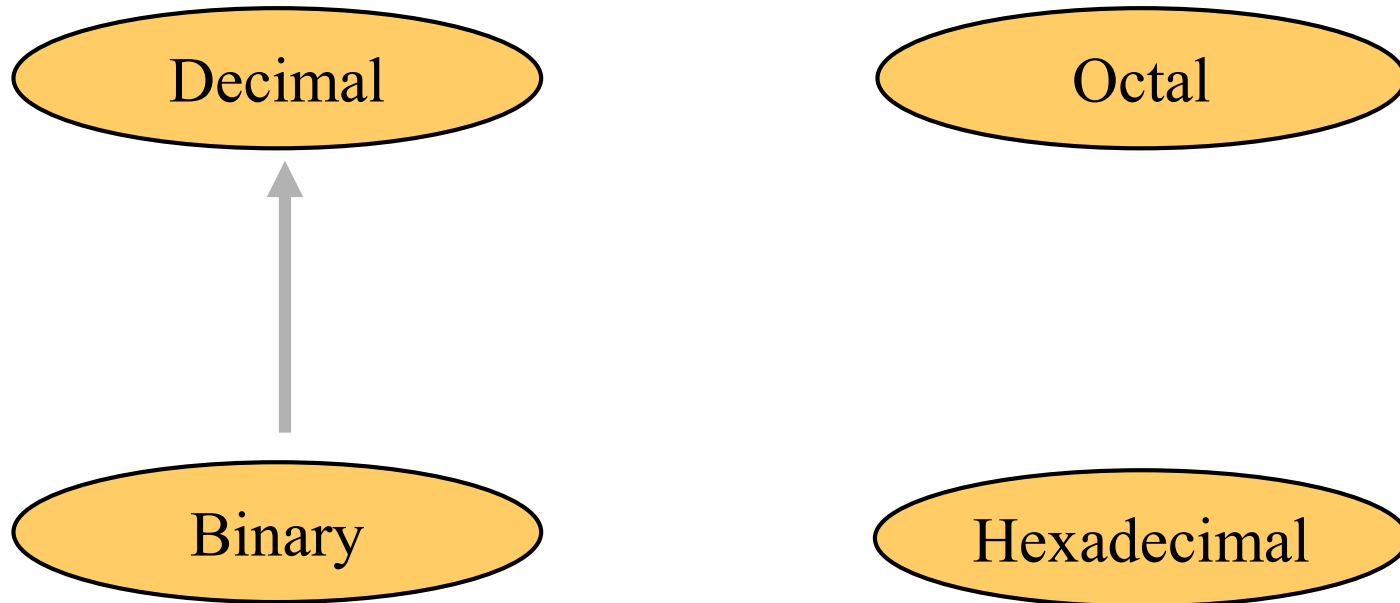
$$25_{10} = 11001_2 = 31_8 = 19_{16}$$



Base

# Binary to Decimal

8





# Binary to Decimal

9

## □ Technique

- Multiply each bit by  $2^n$ , where  $n$  is the “weight” of the bit
- The weight is the position of the bit, starting from 0 on the right
- Add the results

# Example:

10

Bit "0"

$$101011_2 \Rightarrow \begin{array}{r} 1 \times 2^0 = 1 \\ 1 \times 2^1 = 2 \\ 0 \times 2^2 = 0 \\ 1 \times 2^3 = 8 \\ 0 \times 2^4 = 0 \\ 1 \times 2^5 = 32 \\ \hline 43_{10} \end{array}$$

# Exercise:

11

- $1011_2 = (?)_{10}$

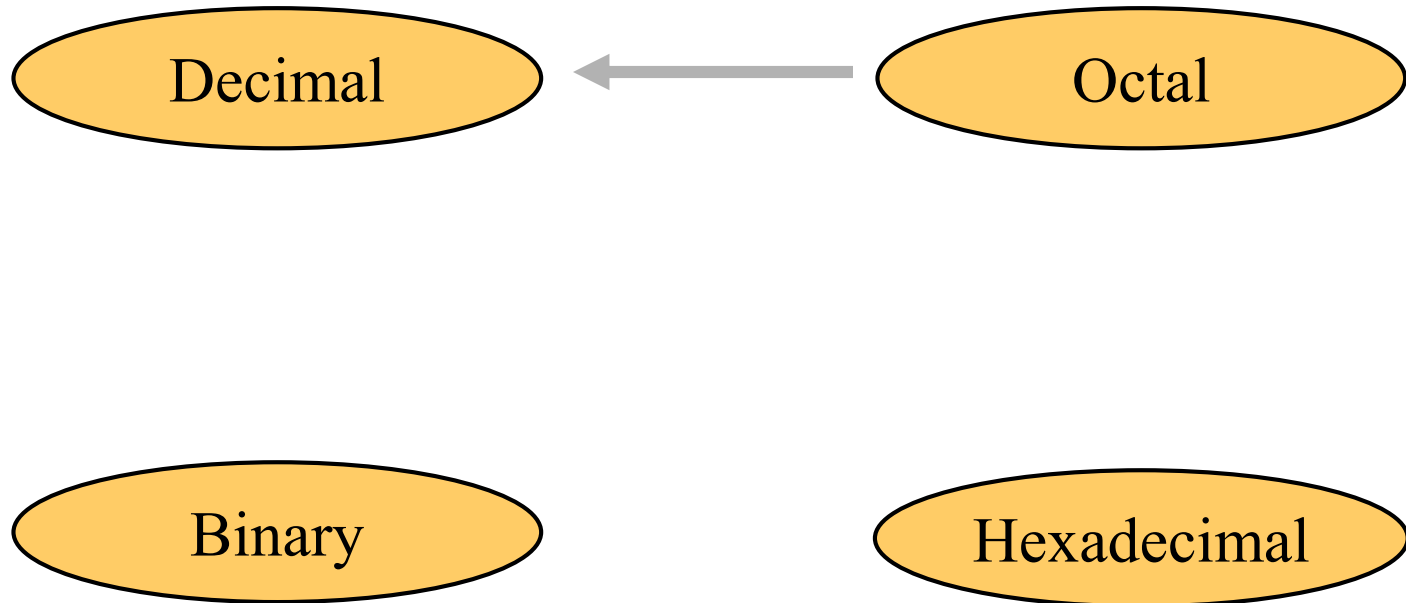
**Answer: 11**

- $101000_2 = (?)_{10}$

**Answer: 40**

# Octal to Decimal

12



# Octal to Decimal

13

## □ Technique

- Multiply each bit by  $8^n$ , where  $n$  is the “weight” of the bit
- The weight is the position of the bit, starting from 0 on the right
- Add the results

# Example:

14

$$\begin{array}{r} 724_8 \Rightarrow \\ 4 \times 8^0 = 4 \\ 2 \times 8^1 = 16 \\ 7 \times 8^2 = 448 \\ \hline 468_{10} \end{array}$$

# Exercise:

15

- $36_8 = (?)_{10}$

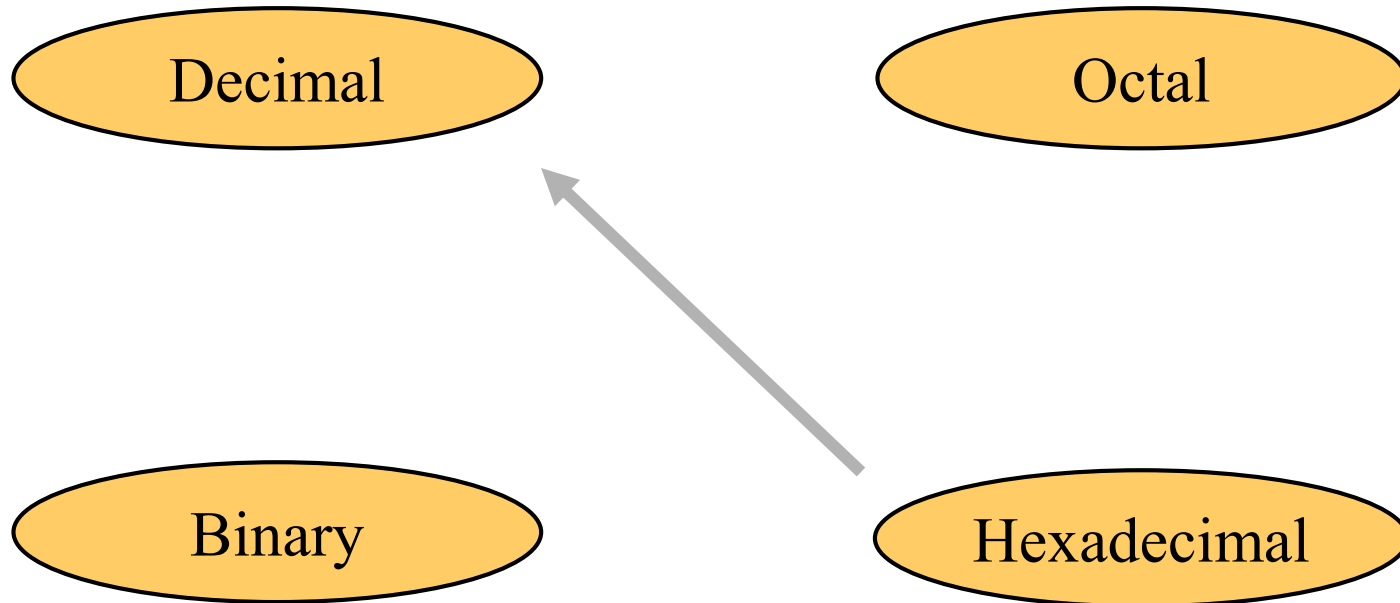
**Answer: 30**

- $564_8 = (?)_{10}$

**Answer: 372**

# Hexadecimal to Decimal

16





# Hexadecimal to Decimal

17

## □ Technique

- Multiply each bit by  $16^n$ , where  $n$  is the “weight” of the bit
- The weight is the position of the bit, starting from 0 on the right
- Add the results

# Example:

18

$$\begin{array}{r} ABC_{16} \Rightarrow \\ C \times 16^0 = 12 \times 1 = 12 \\ B \times 16^1 = 11 \times 16 = 176 \\ A \times 16^2 = 10 \times 256 = \underline{2560} \\ \phantom{A \times 16^2 = 10 \times 256 = } 2748_{10} \end{array}$$

# Exercise:

19

- $5B16_{16} = (?)_{10}$

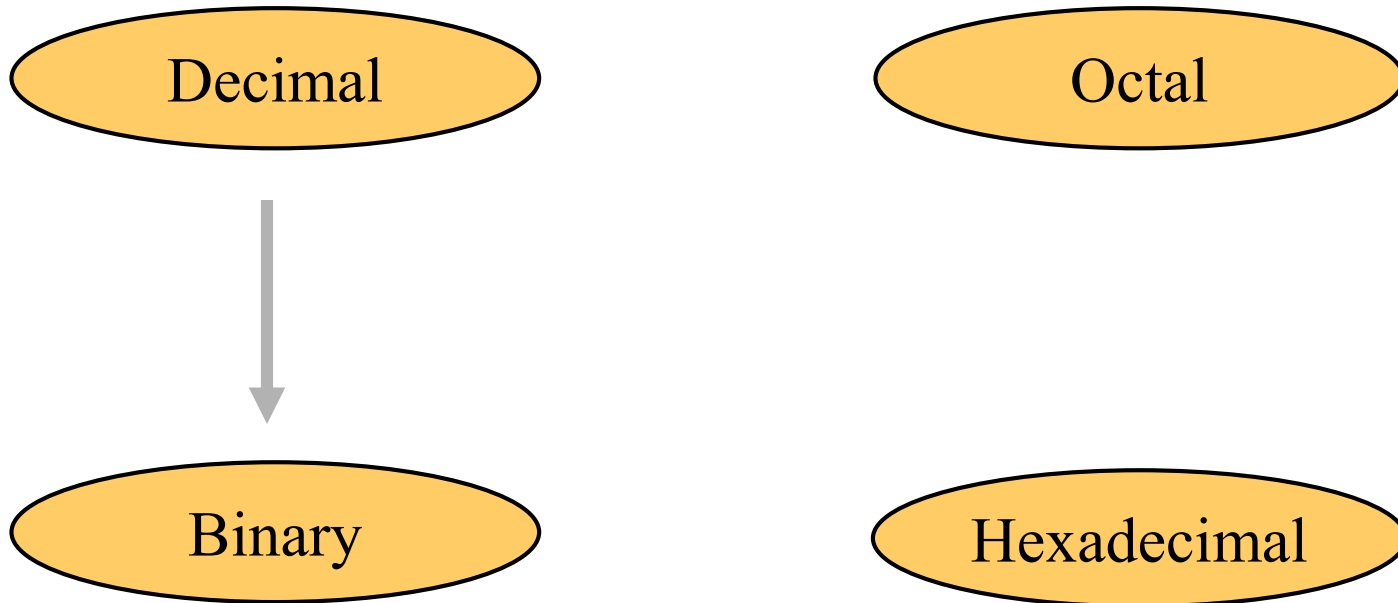
**Answer: 23318**

- $FA54_{16} = (?)_{10}$

**Answer: 64084**

# Decimal to Binary

20



# Decimal to Binary

21

## □ Technique

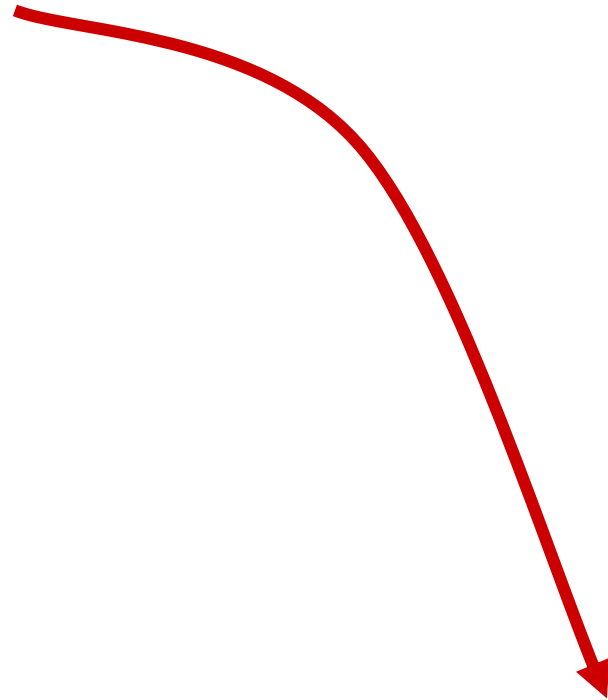
- ▣ Divide by two, keep track of the remainder
- ▣ First remainder is bit 0 (LSB, least-significant bit)
- ▣ Second remainder is bit 1
- ▣ Etc.

# Example:

22

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

2		125	
2		62	1
2		31	0
2		15	1
2		7	1
2		3	1
2		1	1
		0	1



$$125_{10} = 1111101_2$$

# Exercise:

23

- $27_{10} = (?)_2$

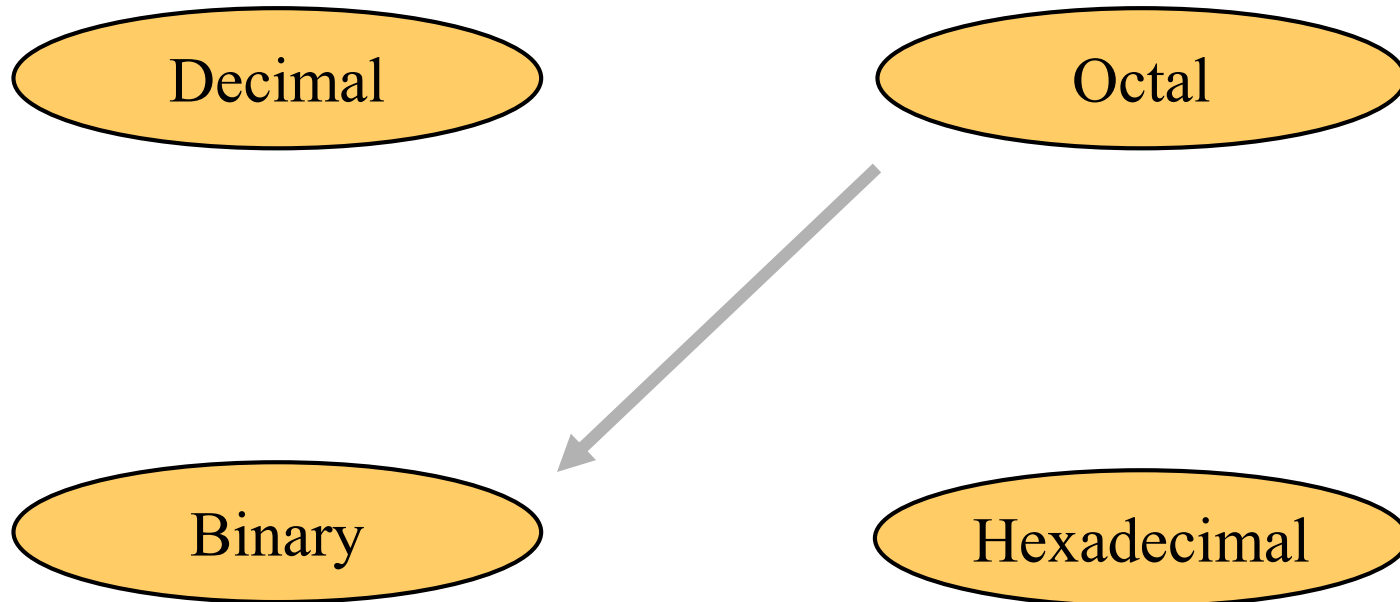
**Answer: 11011**

- $173_{10} = (?)_2$

**Answer: 101011001**

# Octal to Binary

24





# Octal to Binary

25

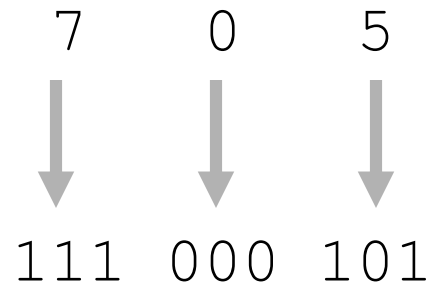
## □ Technique

- ▣ Convert each octal digit to a 3-bit equivalent binary representation

# Example:

26

$$705_8 = ?_2$$



$$705_8 = 111000101_2$$

# Exercise:

27

- $247_8 = (?)_2$

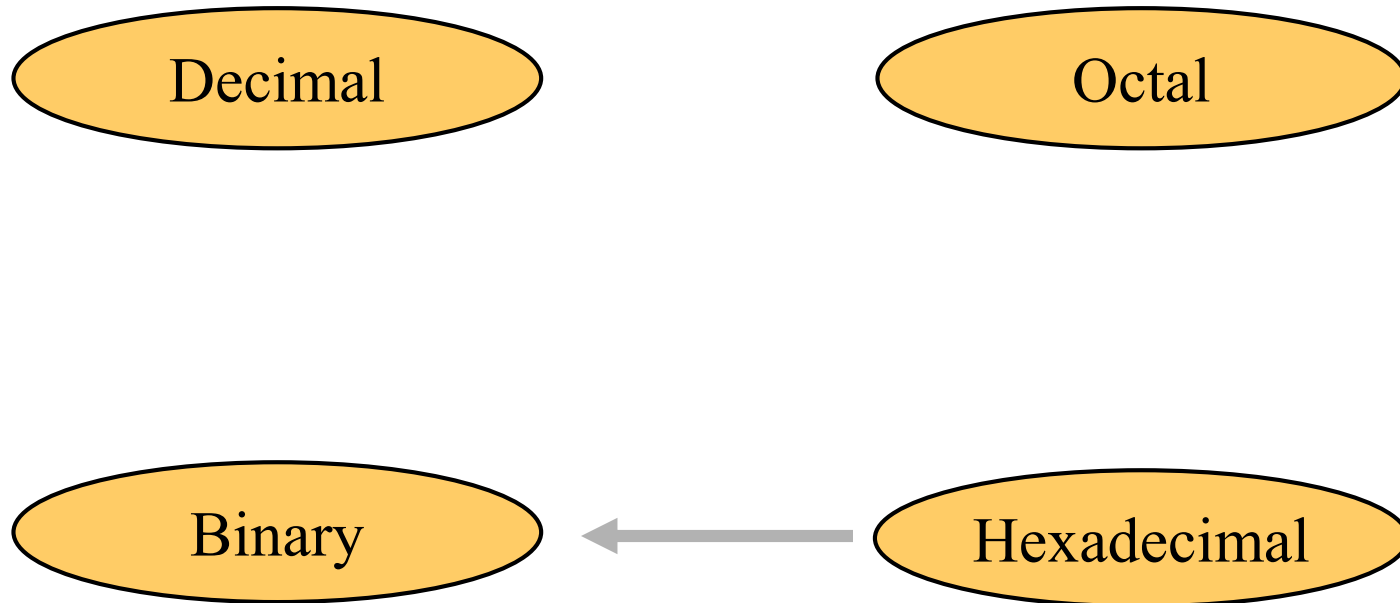
**Answer: 10100111**

- $3567_8 = (?)_2$

**Answer: 011101110111**

# Hexadecimal to Binary

28



# Hexadecimal to Binary

29

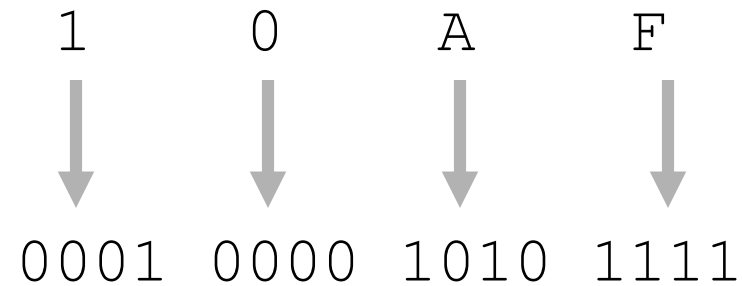
## □ Technique

- ▣ Convert each hexadecimal digit to a 4-bit equivalent binary representation

# Example:

30

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



$$10AF_{16} = 0001000010101111_2$$

# Exercise:

31

- $1A6_{16} = (?)_2$

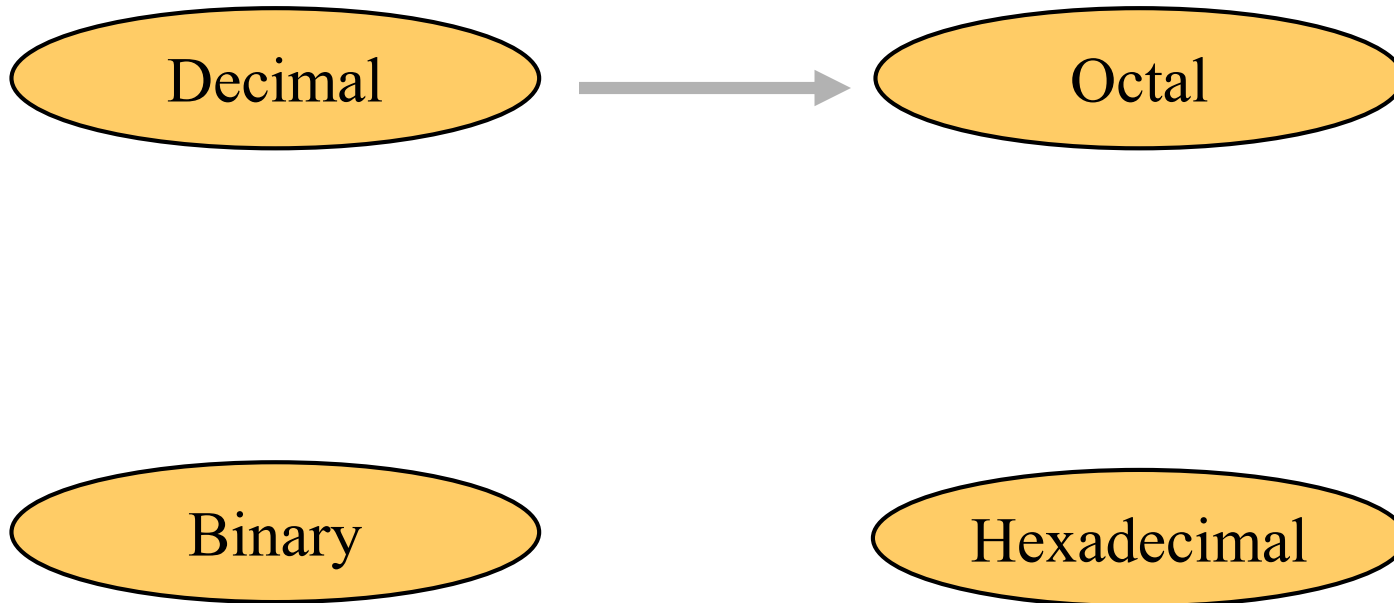
**Answer: 000110100110**

- $AE1_{16} = (?)_2$

**Answer: 10101110001**

# Decimal to Octal

32





# Decimal to Octal

33

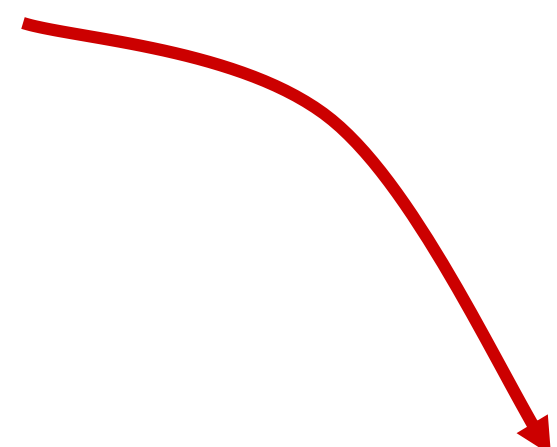
- Technique
  - ▣ Divide by 8
  - ▣ Keep track of the remainder

# Example:

34

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

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



$$1234_{10} = 2322_8$$

# Exercise:

35

- $891_{10} = (?)_8$

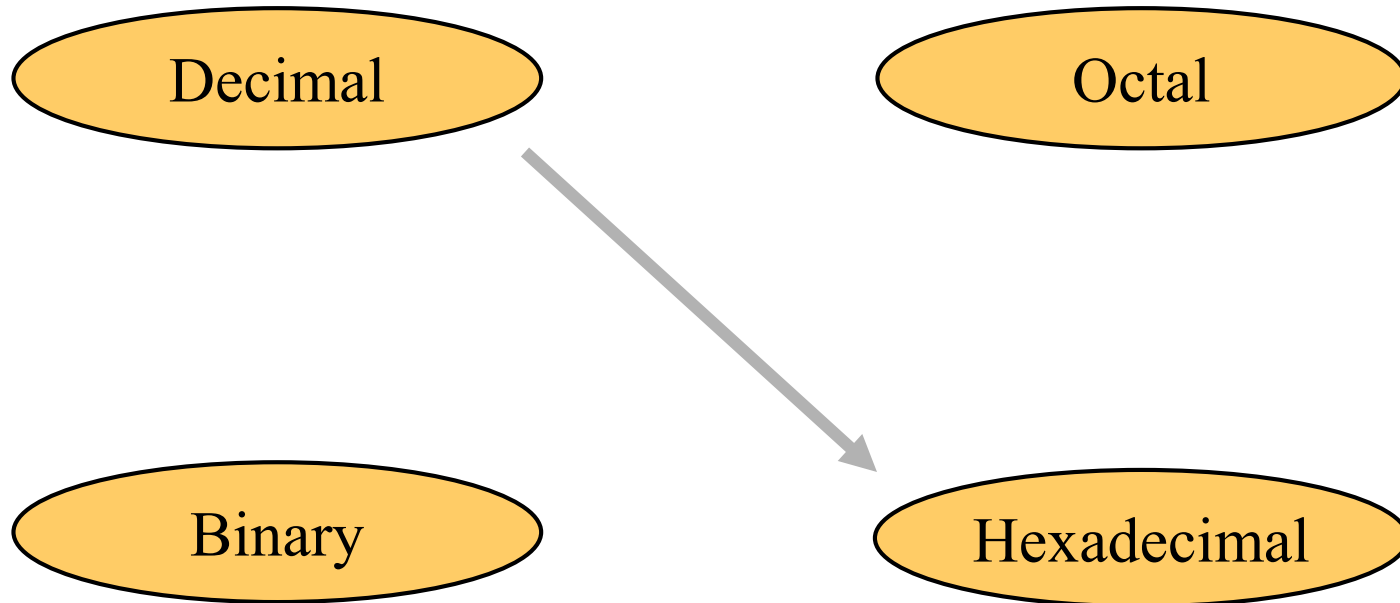
**Answer: 1573**

- $1792_{10} = (?)_8$

**Answer: 3400**

# Decimal to Hexadecimal

36



# Decimal to Hexadecimal

37

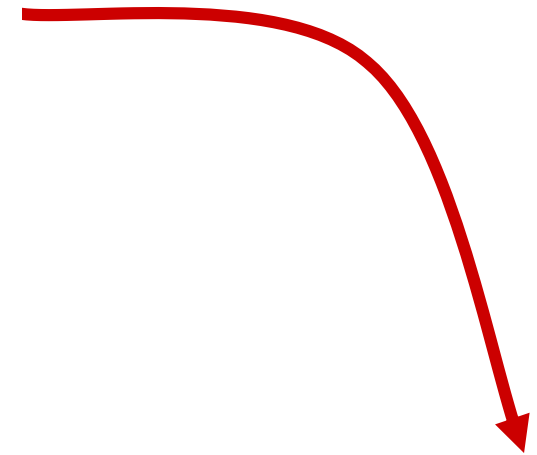
- Technique
  - ▣ Divide by 16
  - ▣ Keep track of the remainder

# Example:

38

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

$$\begin{array}{r|l} 16 & 1234 \\ \hline 16 & \quad 77 \quad 2 \\ \hline 16 & \quad \quad 4 \quad 13 = D \\ \hline & \quad \quad \quad 0 \quad 4 \end{array}$$



$$1234_{10} = 4D2_{16}$$

# Exercise:

39

- $1128_{10} = (?)_{16}$

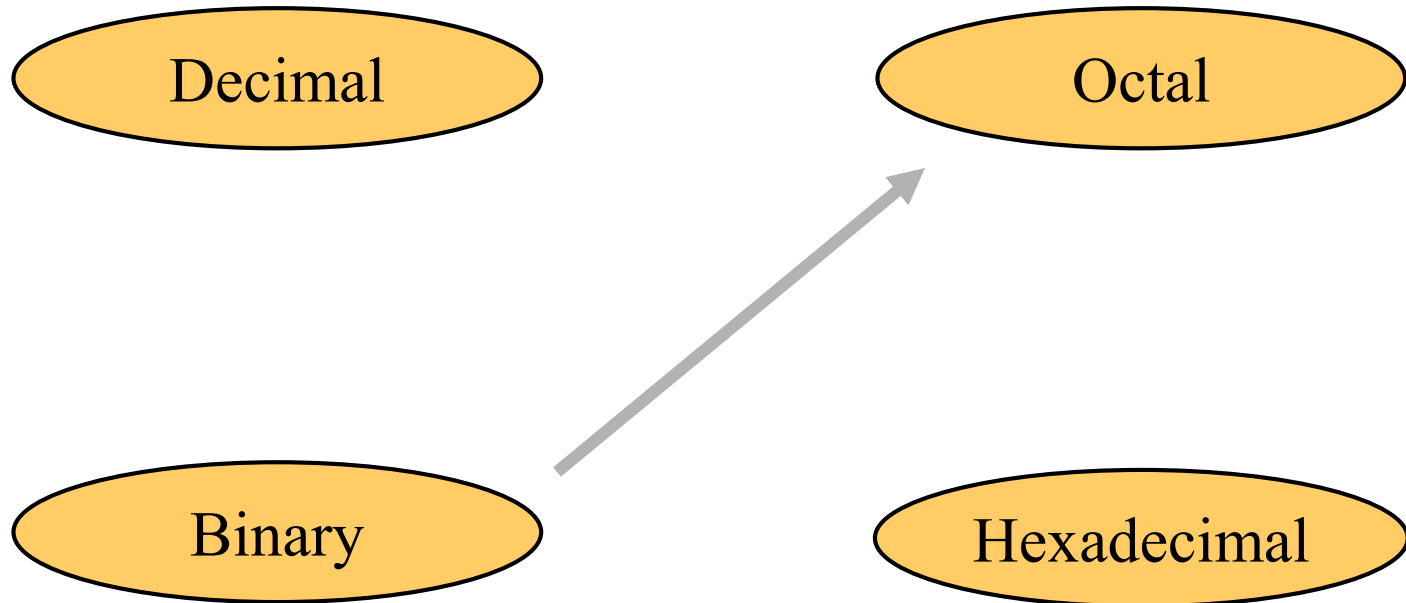
**Answer: 468**

- $317547_{10} = (?)_{16}$

**Answer: 4D86B**

# Binary to Octal

40





# Binary to Octal

41

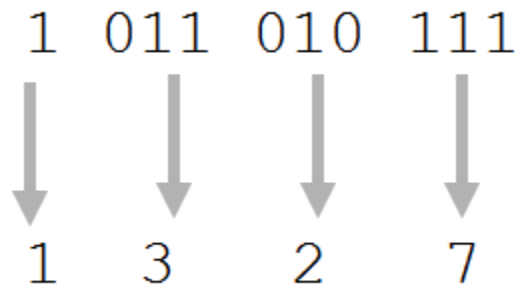
## □ Technique

- ▣ Group bits in threes, starting on right
- ▣ Convert to octal digits

# Example:

42

$$1011010111_2 = ?_8$$



$$1011010111_2 = 1327_8$$

# Exercise:

43

- $110001100_2 = (?)_8$

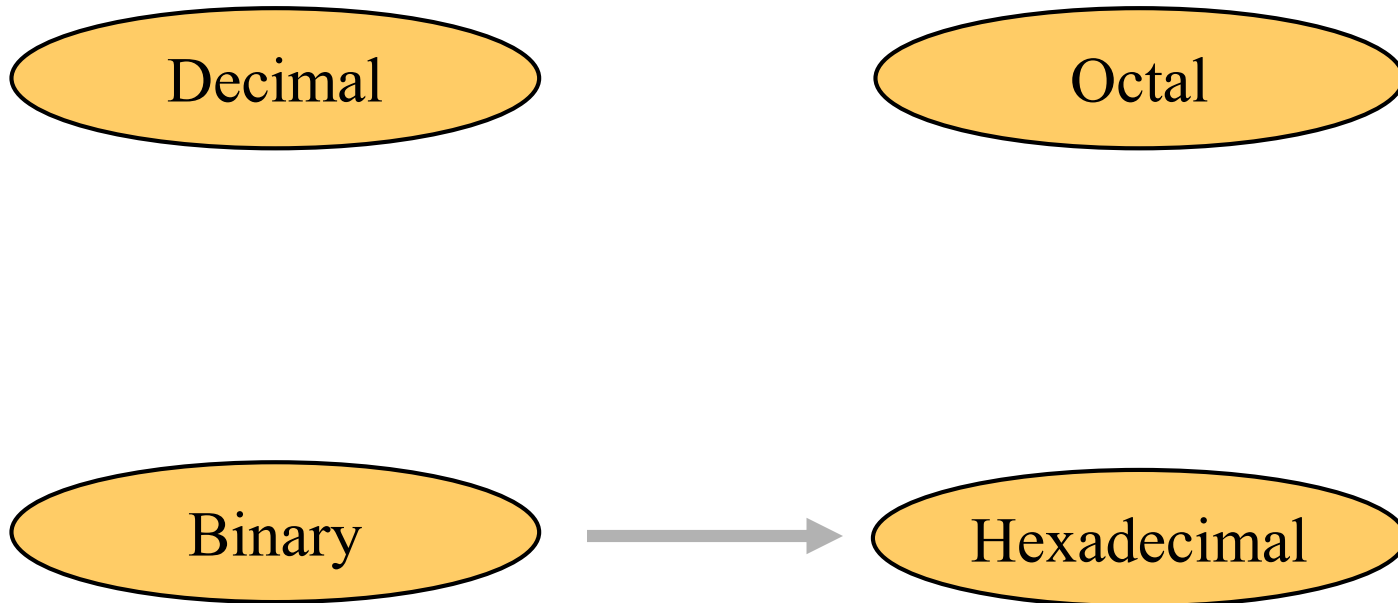
**Answer: 614**

- $1010101_2 = (?)_8$

**Answer: 125**

# Binary to Hexadecimal

44



# Binary to Hexadecimal

45

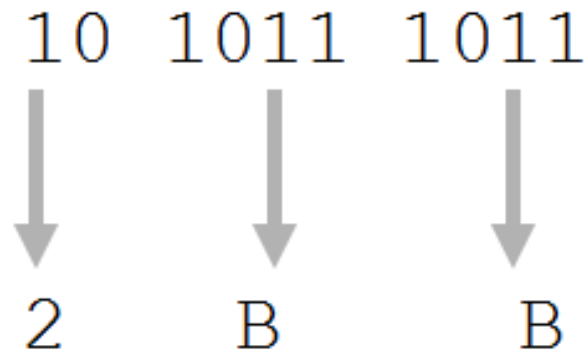
## □ Technique

- ▣ Group bits in fours, starting on right
- ▣ Convert to hexadecimal digits

# Example:

46

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



$$1010111011_2 = 2BB_{16}$$

# Exercise:

47

- $01001110_2 = (?)_{16}$

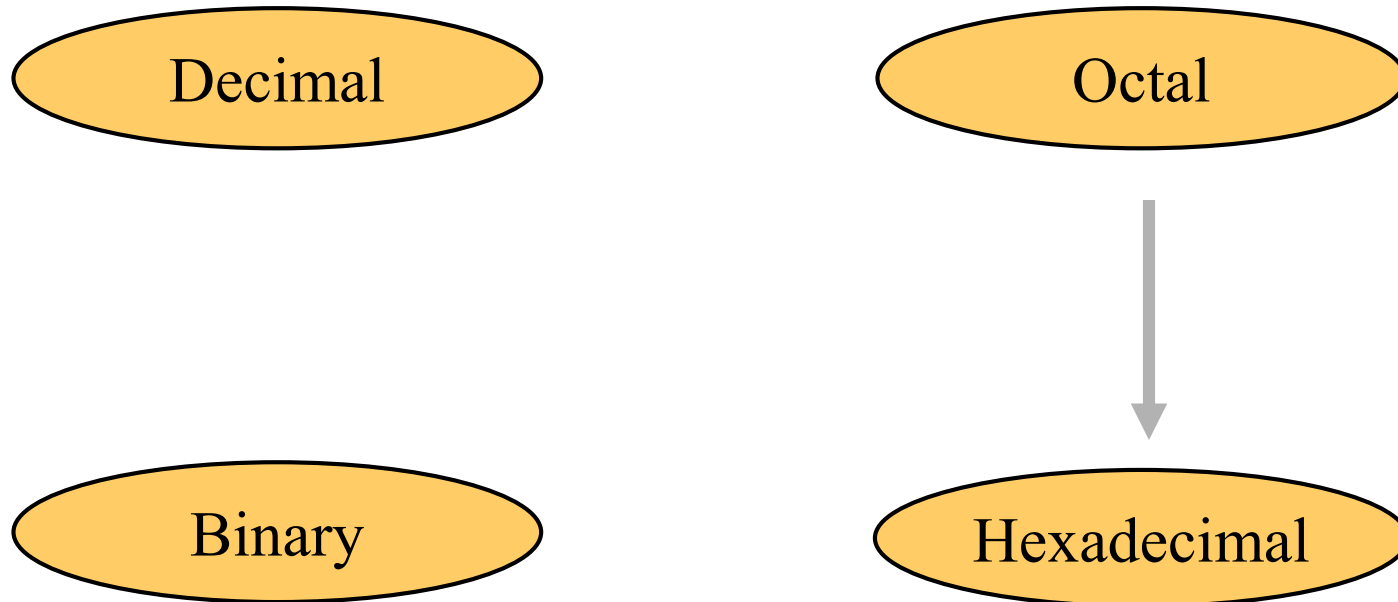
**Answer: 4E**

- $0100101000000001_2 = (?)_{16}$

**Answer: 4A01**

# Octal to Hexadecimal

48





# Octal to Hexadecimal

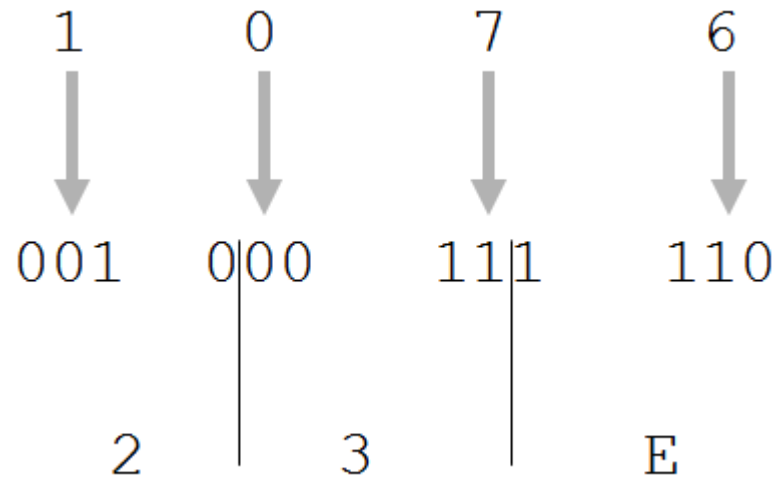
49

- Technique
  - ▣ Use binary as an intermediary

# Example:

50

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



$$1076_8 = 23E_{16}$$

# Exercise:

51

- $1002_8 = (?)_{16}$

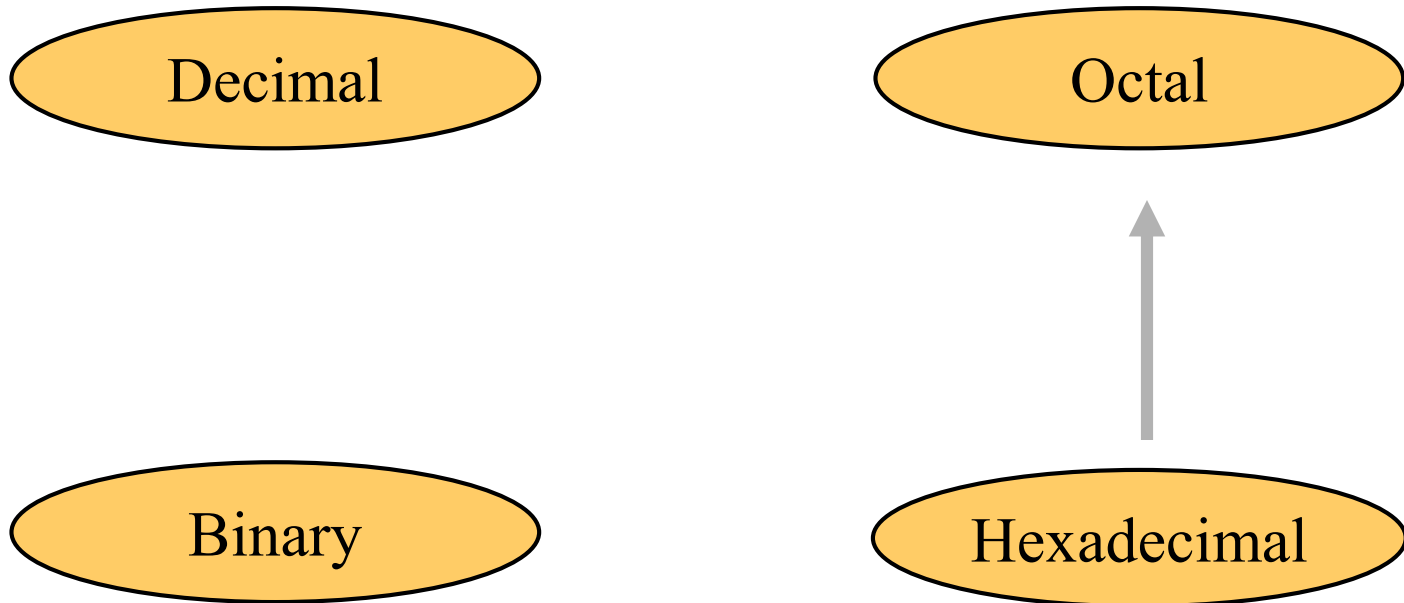
**Answer: 202**

- $2524_8 = (?)_{16}$

**Answer: 554**

# Hexadecimal to Octal

52



# Hexadecimal to Octal

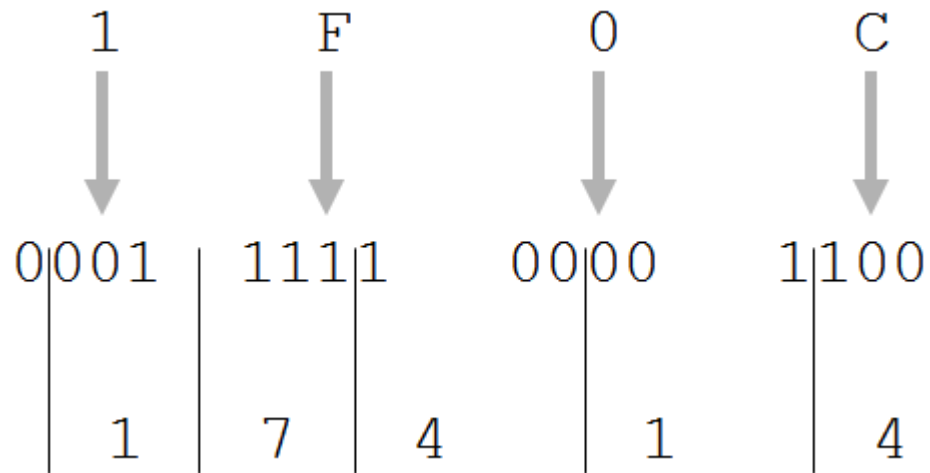
53

- Technique
  - ▣ Use binary as an intermediary

# Example:

54

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



$$1F0C_{16} = 17414_8$$

# Exercise:

55

- $B78_{16} = (?)_8$

**Answer: 5570**

- $BAC9_{16} = (?)_8$

**Answer: 135311**

# Exercise – Convert ...

56

Decimal	Binary	Octal	Hexa- decimal
33			
	1110101		
		703	
			1AF



# Exercise – Convert ...

57

Decimal	Binary	Octal	Hexa- decimal
33	100001	41	21
117	1110101	165	75
451	111000011	703	1C3
431	110101111	657	1AF

# END