Information System

Module Code: INFS-111

Programs: BCSS/BBIT

Data

- Data Consists of the raw facts and figures that are processed into Information.
- Most people mistaken Data being a physical object.

Characteristics of Data

- **Data** have **a true value**
- **Data** needs to be **represented**
- **Data** can be **encoded** and **decoded**

Representation of Data

- Data in computers is dictated using electronic circuit inside the computer and can only take **two** different **states**. These states include **ON** and **OFF**. This indicates whether electric charge is present **(ON)** or **NOT.**
- That's the reason why computers are called **Binary** because they only work with **2** values.

Representation of Data

- Data only exists if it is represented in some form a Matter or Energy.
- **Storage Medium-**The physical encapsulation of the data
- **A number system that has just two unique digits, 0 and 1**
  - A single digit is called a bit (binary digit)
  - A bit is the smallest unit of data the computer can represent
  - By itself a bit is not very informative

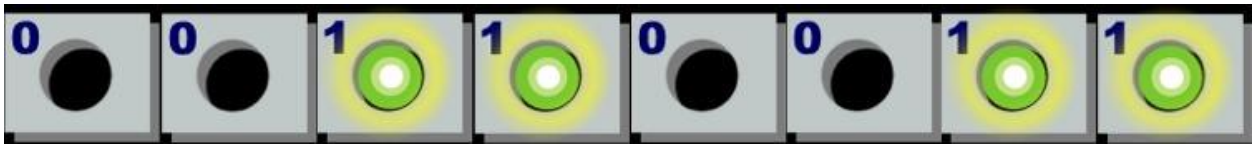
  A Bit is the smallest unit of Information

Representation of Data

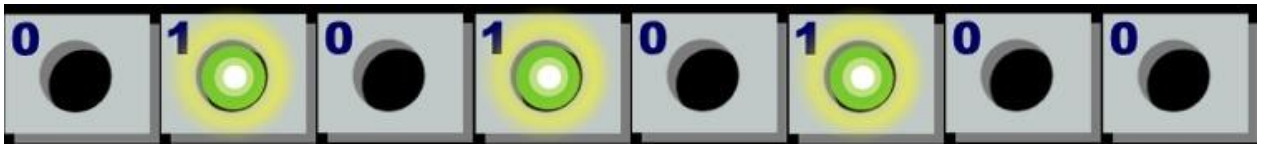
- What is a Byte?

- **Eight bits** are grouped together to form a **byte**
- **0s and 1s** in each byte are used to represent individual characters such as letters of the alphabet, numbers, and punctuation

8-bit byte for the number 3



8-bit byte for the capital letter T



How Computers Store Numbers

- Expanding Decimal**(base10)** Numbering System

1 2 7 5_{10}

5	x	10^0	=	5	x	1	=	5
7	x	10^1	=	7	x	10	=	70
2	x	10^2	=	2	x	100	=	200
1	x	10^3	=	1	x	1000	=	1000

								1275 $_{10}$

1 0 4 0 6_{10}

6	x	10^0	=	6	x	1	=	6
0	x	10^1	=	0	x	10	=	0
4	x	10^2	=	4	x	100	=	400
0	x	10^3	=	0	x	1000	=	0
1	x	10^4	=	1	x	10000	=	10000

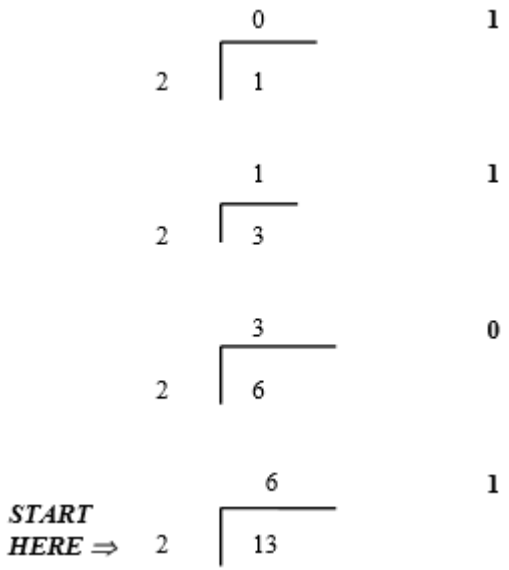
								10406 $_{10}$

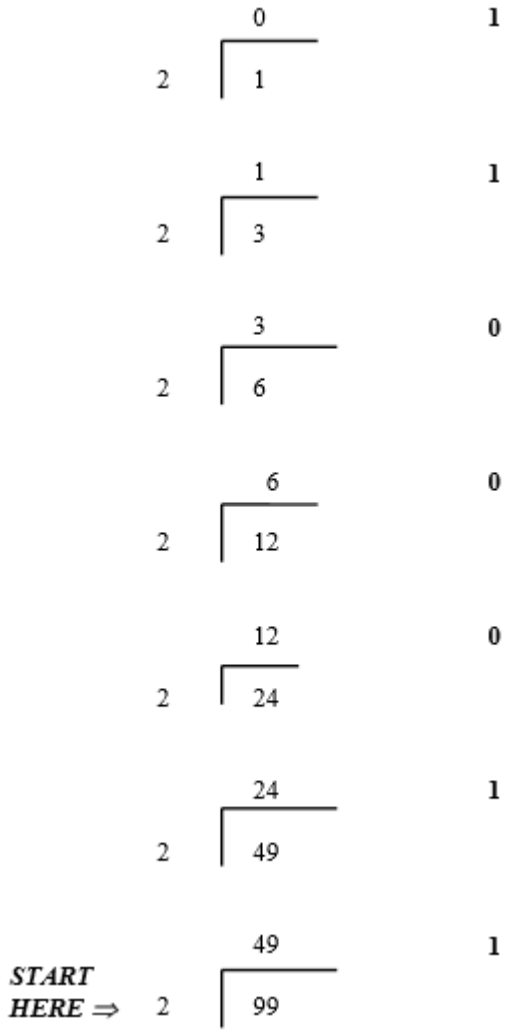
How Computers Store Numbers

- **Expanding Binary Number System**
- Digital computers internally use the binary (base 2) number system to represent data and perform arithmetic calculations.

How Computers Store Numbers

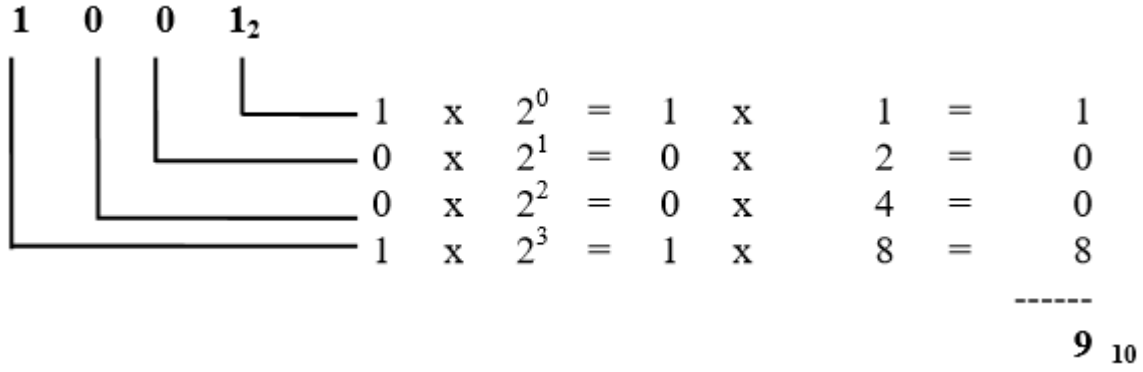
- **Converting Decimal to Binary**
- The answer 99 = 1100011.
- The answer 13 = 1101

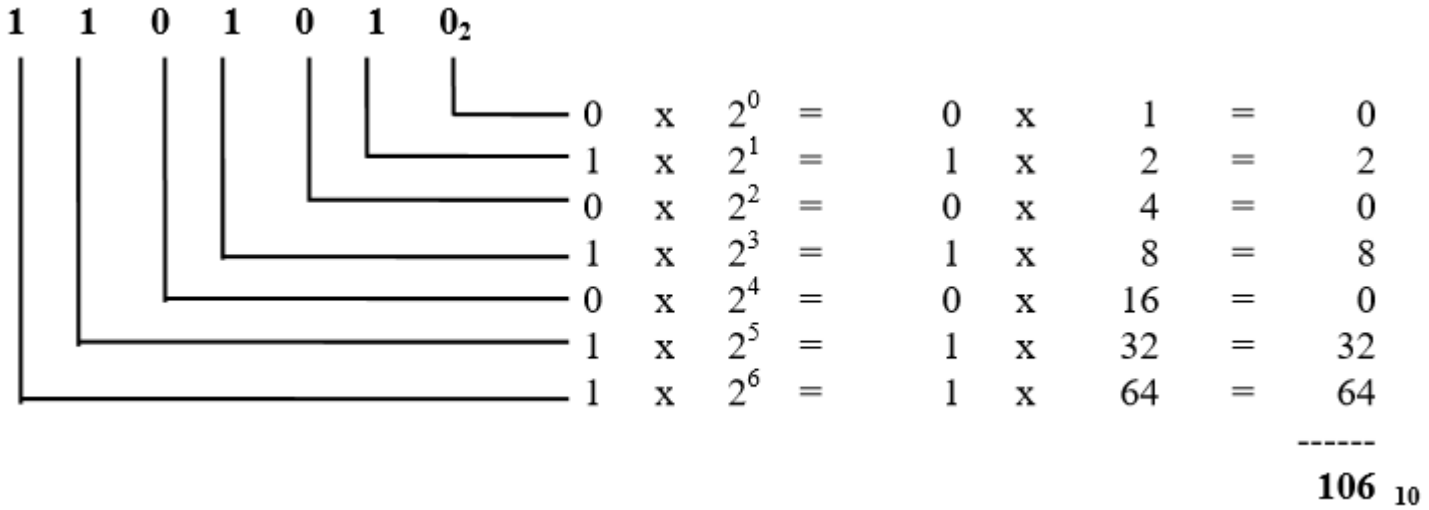




How Computers Store Numbers

- **Converting Binary to Decimal**





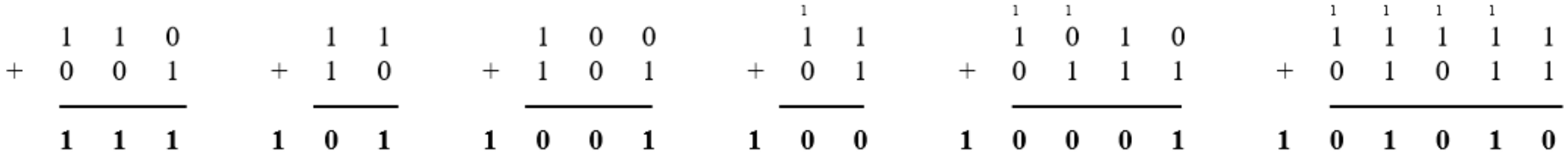
How Computers Store Numbers

- **Binary Addition**
- Adding two binary numbers together is easy, keeping in mind the following rules:

(1)	**0**	+	**0**	=	**0**
(2)	**0**	+	**1**	=	**1**
(3)	**1**	+	**0**	=	**1**
(4)	**1**	+	**1**	=	**10**

How Computers Store Numbers

- **Binary Addition**



How Computers Store Numbers

- **Subtracting Decimal using complements**
- **(4589-322)**

1. First, we'll compute the four digit nine's complement of the subtrahend 0322 (we must add the leading zero in front of the subtrahend to make it the same size as the minuend):

9	9	9	9
- 0	- 3	- 2	- 2
9	6	7	7

How Computers Store Numbers

- **Subtracting Decimal using complements**

2. Add 1 to the nine's complement of the subtrahend (9677) giving the ten's complement of subtrahend (9678):

$$\begin{array}{r} 9\ 6\ 7\ 7 \\ +\ \ \ 1 \\ \hline 9\ 6\ 7\ 8 \end{array}$$

How Computers Store Numbers

- **Subtracting Decimal using complements**

3. Add the ten's complement of the subtrahend to the minuend giving 14267. Drop the leading 1, effectively performing the subtraction of 4589 - 0322 = 4267.

The answer can be c

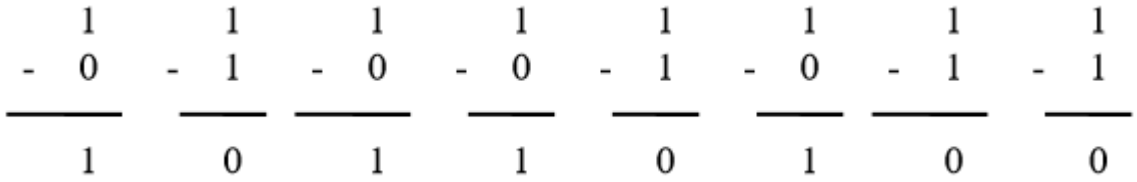
$$\begin{array}{rrrrr} & 4 & 5 & 8 & 9 \\ + & 9 & 6 & 7 & 8 \\ \hline \cancel{1} & 4 & 2 & 6 & 7 \end{array}$$

ing sure that 322 + 4267 = 4589.

How Computers Store Numbers

- **Subtracting Binary using complements**

1. Compute the one's complement of 1001011_2 by subtracting each digit from 1



How Computers Store Numbers

- **Subtracting Binary using complements**

2. Add 1 to the one's complement of the subtrahend, giving the two's complement of the subtrahend:

1	0	1	1	0	1	0	0
						+	1
1	0	1	1	0	1	0	1

How Computers Store Numbers

3. Add the two's complement of the subtrahend to the minuend and drop the high-order 1, giving the difference:

	1	1	0	1	0	1	0	1
+	1	0	1	1	0	1	0	1
±	1	0	0	0	1	0	1	0

So $\mathbf{11010101_2}$ -

The answer can be checked by making sure that $\mathbf{1001011_2 + 10001010_2 = 11010101_2}$.

Decimal	Octal	Decimal	Octal
0	0	16	20
1	1	17	21
2	2	18	22
3	3	19	23
4	4	20	24
5	5	21	25
6	6	22	26
7	7	23	27
8	10	24	30
9	11	25	31
10	12	26	32
11	13	27	33
12	14	28	34
13	15	29	35
14	16	30	36
15	17	31	37

How Computers Store Numbers

- **Converting Octal to Decimal**

3 6 7_8

$7 \times 8^0 = 7 \times 1 = 7$

$6 \times 8^1 = 6 \times 8 = 48$

$3 \times 8^2 = 3 \times 64 = 192$

247_{10}

1 6 0 1_8

$1 \times 8^0 = 1 \times 1 = 1$

$0 \times 8^1 = 0 \times 8 = 0$

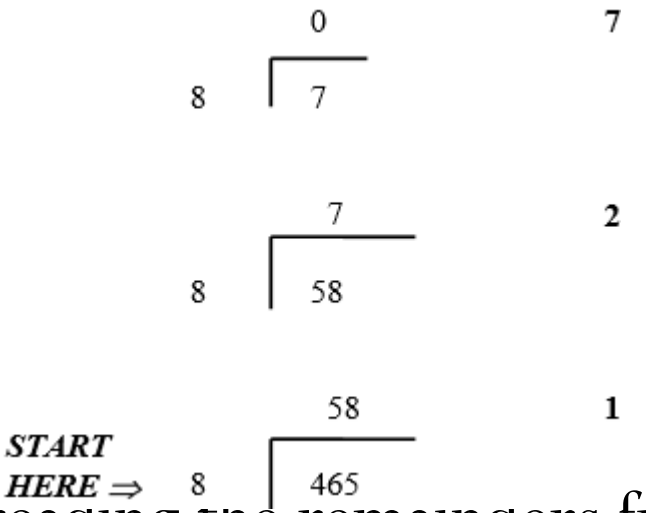
$6 \times 8^2 = 6 \times 64 = 384$

$1 \times 8^3 = 1 \times 512 = 512$

897_{10}

How Computers Store Numbers

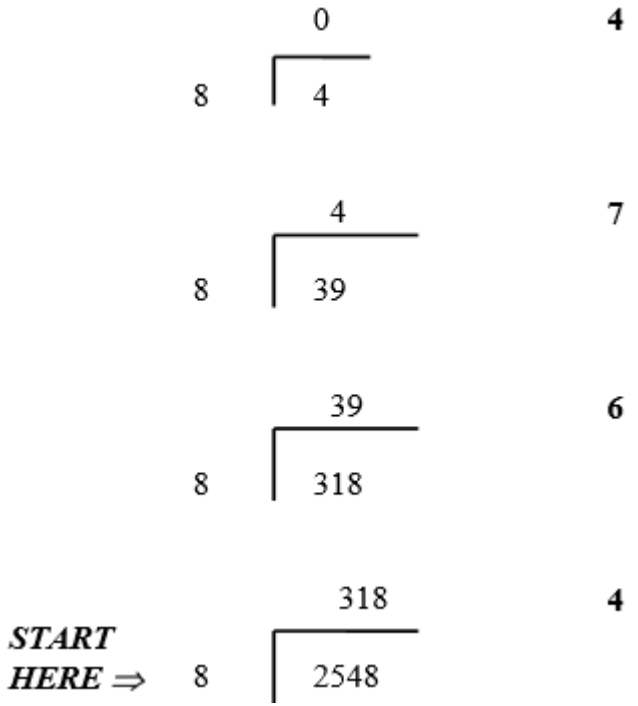
- **Converting Decimal to Octal**
- Convert the decimal number 465 to its octal equivalent



- The answer, reading the remainders from top to bottom, is 721, so 465 = 721

How Computers Store Numbers

- **Converting Decimal to Octal**
- Convert the decimal number 2548 to its octal equivalent



How Computers Store Numbers

- Octal Addition

Example 1: Add $543_8 + 121_8$ (no carry required):

$$\begin{array}{rrrr} & 5 & 4 & 3 \\ + & 1 & 2 & 1 \\ \hline & 6 & 6 & 4 \end{array}$$

Example 2: Add $7652_8 + 4574_8$ (carries required):

$$\begin{array}{rrrrr} & {\scriptstyle 1} & {\scriptstyle 1} & & \\ & 7 & 6 & 5 & 2 \\ + & 4 & 5 & 7 & 4 \\ \hline & 12-8=4 & 12-8=4 & 12-8=4 & \\ \mathbf{1} & \mathbf{4} & \mathbf{4} & \mathbf{4} & \mathbf{6} \end{array}$$

How Computers Store Numbers

- Octal Subtraction using Complement

Example 1: Compute $7526_8 - 3142_8$

(1) Compute the seven's complement of 3142_8 by subtracting each digit from 7:

7	7	7	7
- 3	- 1	- 4	- 2
4	6	3	5

How Computers Store Numbers

- Octal Subtraction using Complement

(2) Add 1 to the seven's complement of the subtrahend, giving the eight's complement of the subtrahend:

$$\begin{array}{r} 4\ 6\ 3\ 5 \\ +\ \ \ 1 \\ \hline 4\ 6\ 3\ 6 \end{array}$$

How Computers Store Numbers

- Octal Subtraction using Complement

(3) Add the eight's complement of the subtrahend to the minuend and drop the high-order 1, giving the difference:

	$^{1}7$	5	$^{1}2$	6
+	4	6	3	6
	12 - 8 = 4	11 - 8 = 3		12 - 8 = 4
	4	**3**	**6**	**4**

So $\mathbf{7526_8 - 3142_8 = 4364_8}$

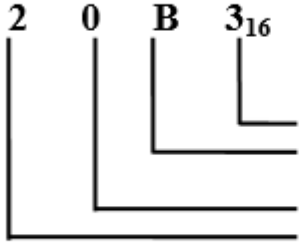
The answer can be checked by making sure that $\mathbf{3142_8 + 4364_8 = 7526_8}$.

Decimal	Hexadecimal	Decimal	Hexadecimal
0	0	16	10
1	1	17	11
2	2	18	12
3	3	19	13
4	4	20	14
5	5	21	15
6	6	22	16
7	7	23	17
8	8	24	18
9	9	25	19
10	A	26	1A
11	B	27	1B
12	C	28	1C
13	D	29	1D
14	E	30	1E
15	F	31	1F

How Computers Store Numbers

- **Converting Hexadecimal to Decimal**

Example 1: Convert the hexadecimal number $20B3_{16}$ to its decimal equivalent.



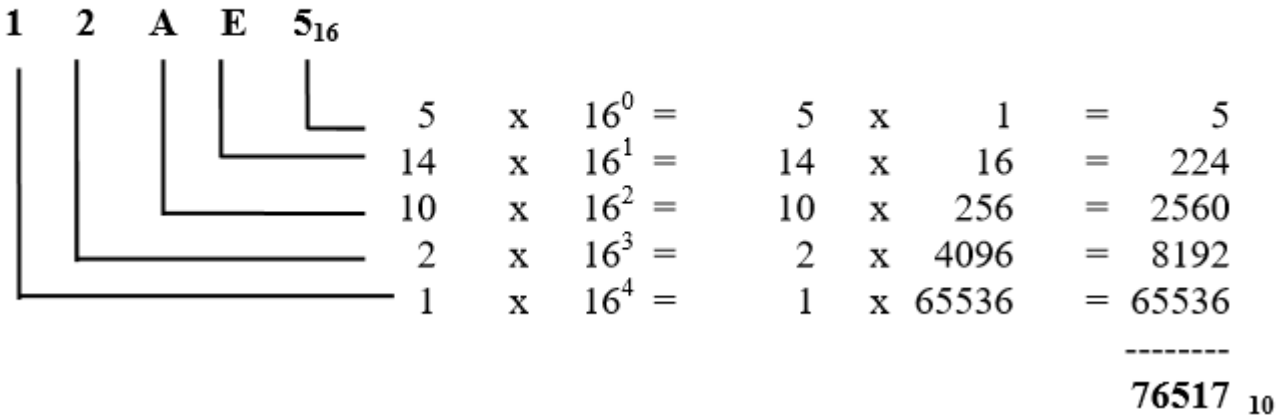
3	x	16^0	=	3	x	1	=	3
11	x	16^1	=	11	x	16	=	176
0	x	16^2	=	0	x	256	=	0
2	x	16^3	=	2	x	4096	=	8192

								8371 $_{10}$

How Computers Store Numbers

- **Converting Hexadecimal to Decimal**

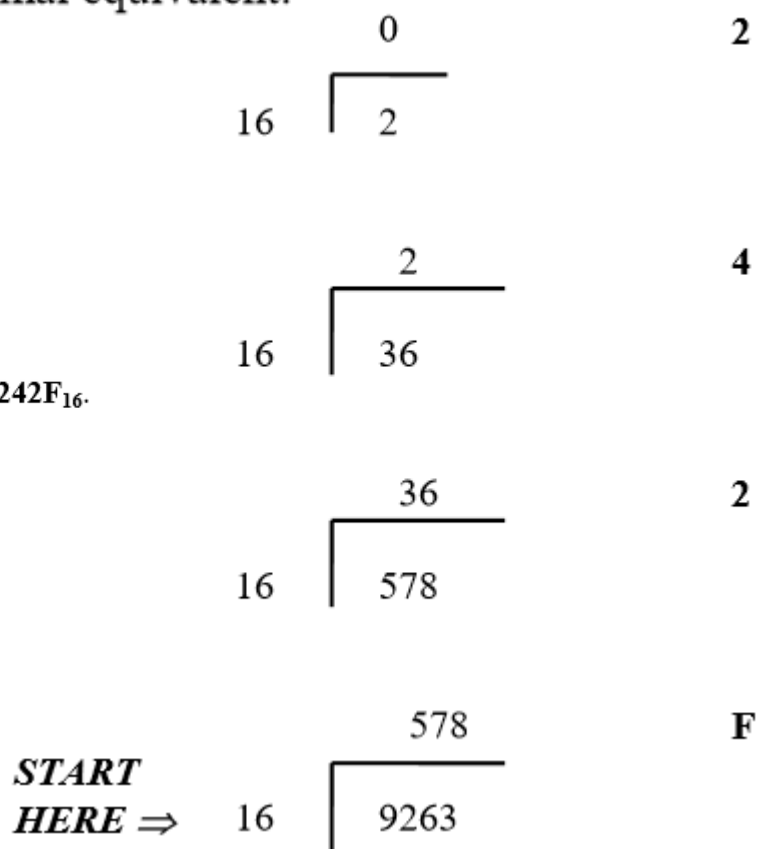
Example 2: Convert the hexadecimal number $12AE5_{16}$ to its decimal equivalent.



How Computers Store Numbers

- **Converting Decimal to Hexadecimal**

Example 1: Convert 9263_{10} to its hexadecimal equivalent:



The answer, reading the remainders from top to bottom, is **242F**, so $\mathbf{9263_{10} = 242F_{16}}$.

How Computers Store Numbers

- Addition of Hexadecimal

	1	9	5
+	3	1	9
	4	A	E

	3	A (10)	2
+	4	1	C (12)
	7	B	E

	1		1	
	8	F (15)	9	7
+	D (13)	5	4	C (12)
	1 + 8+ 13 = 22	15 + 5 = 20		7 + 12 = 19
	22- 16 = 6	20 - 16 = 4		19 - 16 = 3
	1	6	4	E	3

How Computers Store Numbers

- **Subtraction using Complement**

Example 1: Compute $\mathbf{ABED_{16}}$ - $\mathbf{1FAD_{16}}$

(1) Compute the 15's complement of $\mathbf{1FAD_{16}}$ by subtracting each digit from 15:

15	15	15	15
- 1	- F	- A	- D
E	0	5	2

How Computers Store Numbers

- **Subtraction using Complement**

(2) Add 1 to the 15's complement of the subtrahend, giving the 16's complement of the subtrahend:

E	0	5	2
		+	1
E	0	5	3

How Computers Store Numbers

- **Subtraction using Complement**

(3) Add the 16's complement of the subtrahend to the minuend and drop the high-order 1, giving the difference:

	1		1	1	
	A	B	E	D
+	E	0	5	3
	24 - 16 = 8		20 - 16 = 4	16 - 16 = 0
	8	**C**	**4**	**0**

So $\mathbf{ABED_{16} - 1FAD_{16} = 8C40_{16}}$

The answer can be checked by making sure that $\mathbf{1FAD_{16} + 8C40_{16} = ABED_{16}}$.

Reading Assignment

- Please read from **Discovering Information Systems** book on the following topics:
- Representing Data page **11-14**
- Measuring Data page **15-16**
- Information **16-18**