CSE342 MICROPROCESSORS	
	Number Systems
There are three importo familiar with.	ant number systems which you should become
These are decimal , bina i	y and hexadecimal.
	iich is the one you are most familiar with, utilizes t each digit. These are 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.
•Similarly, the binary sy	stem is base 2.
•Hexadecimal is base 16	as shown below:
Number System Radix	Symbols
Binary 2	01
Decimal 10	0123456789
Hexadecimal 16	0123456789ABCDEF
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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	А	
11	1011	В	
12	1100	С	
13	1101	D	
14	1110	Е	
15	1111	F	

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Number Conversion
Now, let us assume that we are working predominantly with the hexadecimal system.
In this case, we split the binary pattern into groups of four bits as follows:
01011101 ₂ = 0101 1101 (Binary)
= 5 D (Hexadecimal)
The conversion to decimal :
5D ₁₆ = (5 x 16) + 13 = 93
The result is: $01011101_2 = 5D_{16} = 93_{10}$
The symbols \$ and h are commonly used to signify hexadecimal notation, for example, \$5D or 5Dh.
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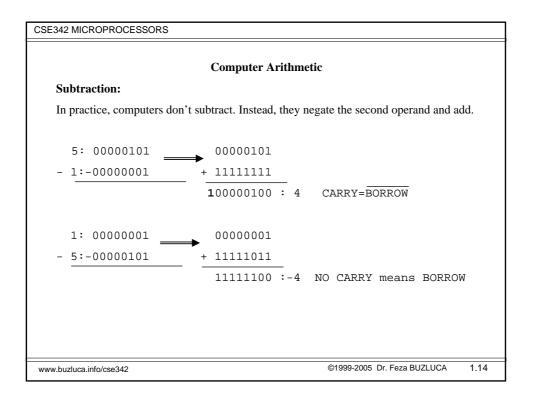
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Data Representation	
•The native language of digital computers is inherently binary .	
 The range of numbers which can be represented is dependent on the number of bits used. A common unit of storage is a byte which is a group of eight bits. 	
•Eight bits can represent 2 ⁸ unique states, i.e. 256 possible combinations.	
 This fact can be used to our advantage to represent many different things on the computer. For example, 	
a byte can be used to represent 256 colors, 256 shades of grey, 256 shapes, 256 symbols, 256 names, or even 256 different numbers. More typically, we can use a byte to represent 256 sequential numbers such as the numbers from 1 to 256, or the numbers from 0 to 255.	
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Signed Numbers As another example, how about the numbers from -128 to 127? Note that there are 256 unique numbers in this range. One scheme to represent signed integers is to reserve one of the eight bits to indicate the sign of the number. Following usual convention, the left-most bit (called the most significant bit or MSB) is dedicated as the sign bit. With this scheme, we can now have 128 positive and 128 negative numbers, typically the numbers from 0 to 127. This scheme has the anomaly that there are two unique representations for positive and negative zero. A more serious problem is that the rules of binary arithmetic breakdown when we decrement by 1 from positive to negative numbers. ©1999-2005 Dr. Feza BUZLUCA 1.11 www.buzluca.info/cse342

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Two's complement representation:		
The two's complement binary system overcom above. In this notation, the negative number is binary complement of the positive number and	represented by forming the	
1. Complement all bits (change all zeros to ones	s and vice versa)	
2. Add one.		
Note that in all the signed binary systems disc represented by the MSB .	ussed, the sign is	
E×ample:		
+5: 0000 0101		
To find -5: Complementing 00000101 yields	11111010	
Adding one yields 11111011: -5		
Sign = 1 means minus		
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	Computer Arithmetic	
Addition:		
Unsigned Numbers: Th	ere is no sign bit	
01110101: 117	11111111: 255	
+ 01100011: 99	+ 00000001: 1	
11011000: 216	1 00000000: 256	
	CARRY	
Signed Numbers:		
11111111: -1	11111111: -1	
+ 00000001: 1	+ 11111111: -1	
10000000: 0	11111110: -2	
/ Sign(+)	Sign(-)	
By addition o	f signed numbers disregard any carry	
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Carry:

In the case of unsigned addition carry occurs when the correct result is too large to be represented.

Borrow:

In the case of unsigned subtraction borrow occurs when the value being subtracted is larger than the value it is subtracted from. If subtraction is performed by negating and adding , there is a borrow if the addition does not produce a carry.

Overflow:

In the case of signed addition and subtraction, overflow occurs when the correct result is either more positive than the largest possible positive value ore more negative than the smallest possible negative one. It is indicated by a result having incorrect sign.

There is overflow if:

poz + poz \rightarrow neg neg + neg \rightarrow poz	poz - neg \rightarrow neg - poz \rightarrow	5	
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