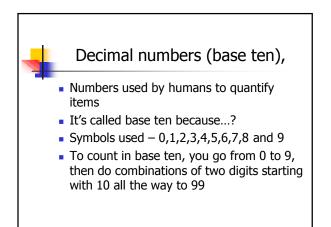
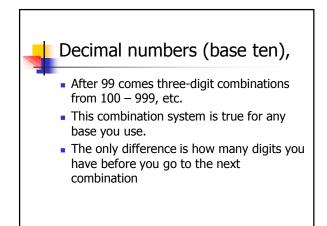
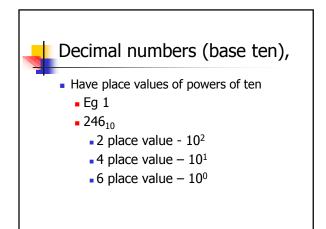
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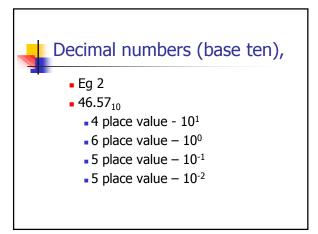
Number Bases

- In this lesson we shall discuss different Number Bases, specifically those used by the computer
- These include:
 - decimal numbers (base ten)
 - binary numbers (base two)
 - octal numbers (base eight)
 - Hexadecimal numbers (base sixteen)



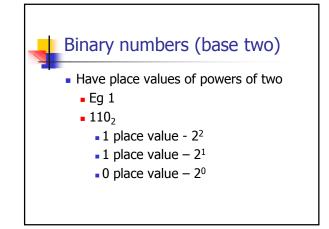


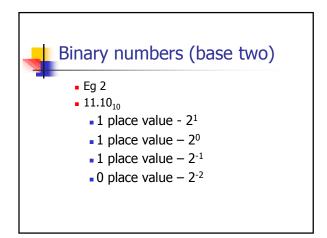


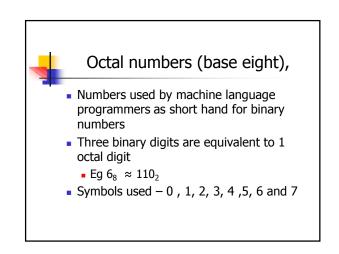


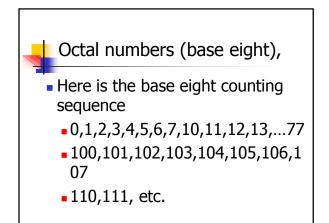
Binary numbers (base two)

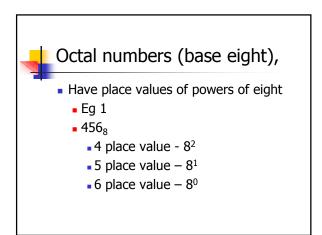
- Numbers used and understood by computers
- Symbols used 0 and 1
- To count in base two,
 - you count 0,1, then switch to two digit combinations, 10,11, then to three digit combos, 100, 101,110,111, then four digit, 1000, _____,, 1111

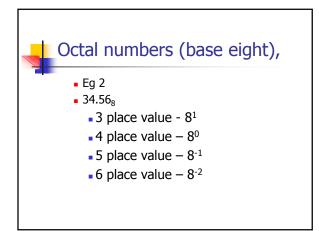






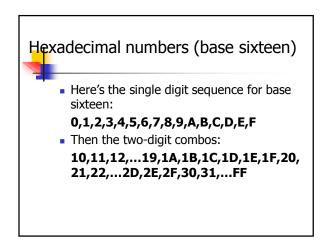


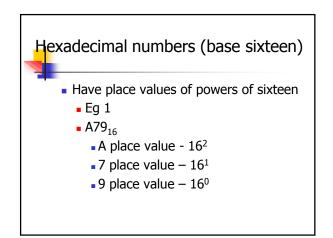


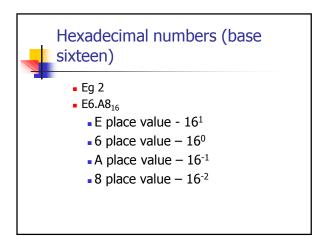


Hexadecimal numbers (base sixteen)

- Numbers used by machine and assembly language programmers to help simply low level programming
- Four binary digits are equivalent to 1 octal digit • Eg $9_{16} \approx 1001_2$
- Symbols used 0 , 1, 2, 3, 4 ,5, 6,7,8,9,10, 11, 12, 13,14 and 15
- Symbols 10, 11, 12, 13, 14 and 15 replaced by letters A, B, C, D, E and F respectively







Base conversionTo convert from base ten to another base,

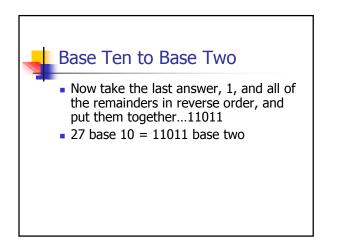
- such as base two, eight, or sixteen, is an important skill for computer scientists and programmers.
- The next section shows how to do this.

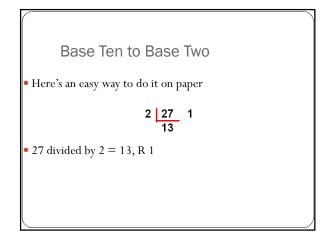
Base Ten to Base Two

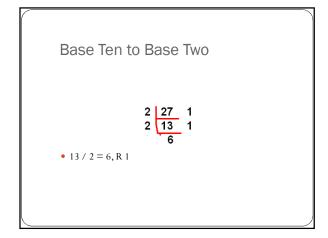
- Let's take the value 27 and convert it into base 2.
- Here's the process:
 - Divide 27 by 2
 - The answer is 13, remainder 1
 - Divide 13 by 2
- Answer is 6, remainder 1

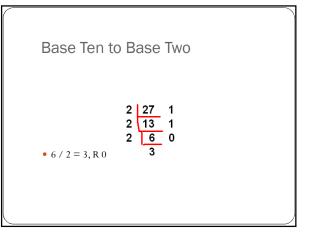
Base Ten to Base Two

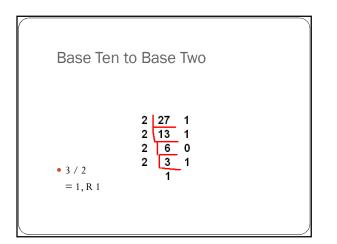
- Continue until the answer is 1.
 - 6 divided by 2 = 3, remainder 0
 - 3 divided by 2 = 1, remainder 1

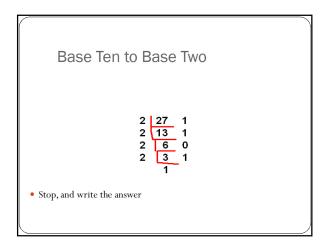


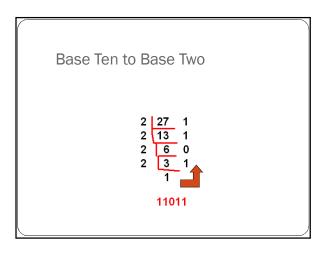




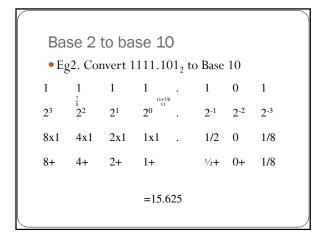


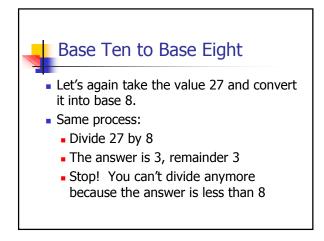






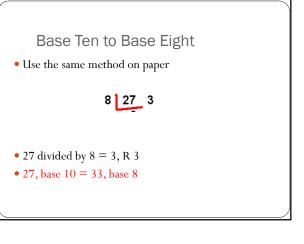
Ba	Base 2 to base 10					
• U	• Use place values to convert.					
• E ₃	g1. Co	nvert 11	011 ₂ to	Base 10		
1		1	0	1	1	
24		2 ³	2 ²	21	20	
16	x1	8x1	4x0	2x1	1x1	
16	+	8+	0+	2+	1	
					=27 ₁₀	





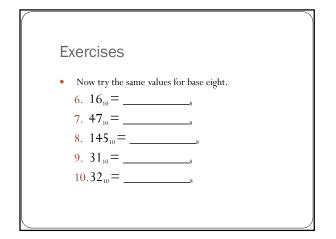
Base Ten to Base Eight

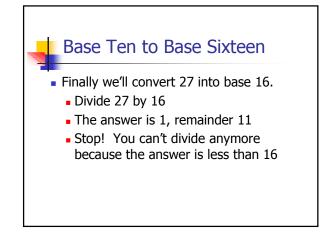
• The last answer was 3, and the only remainder was 3, so the base eight value is 33, base 8.



Base 8 to Base 10							
• Use pl	• Use place values to convert						
• Eg 1 C	• Eg 1 Covert 2657 ₈ to Base 10						
2	6	5	7				
83	8 ²	81	8^{0}				
512x2	64x6	8x5	1x8				
1024+	384+	40+	8+				
	1456 ₁₀						

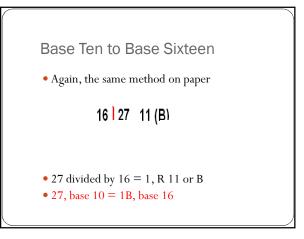
Base 8 to Base 10						
• Eg2 Covert 327.24 ₈ to Base 10						
3	2	7.	2	4		
82	81	80	8-1	8-2		
64x3	8x2	1x7	1/8x2	1/64 x 4		
192+	16+	7+	1/4+	1/16		
=215+5/16 =215.3125						





Base Ten to Base Sixteen

• The last answer was 1, and the only remainder was 11, which in base 16 is the letter B, so the base sixteen value is 1B, base 16.



Base 16 to Base 10 • E.g Covert 12AE ₁₆ to base 10						
1	2	А	Е			
16 ³	16 ²	16 ¹	16 ⁰			
4096x1	256x2	16x10	1x 15			
4096+	512+	160+	15			
=4783 ₁₀						

• E(G 2, Conv	vert 62A.48 ₁₆ TO E	BASE 10		
6 16 ²	2 16 ¹	A . 16 ⁰	4 16 ⁻¹	8 16 ⁻²	
256x6	16x2	1x10	1/16x4	1/256 x 4	
1536+	32+	10+	1⁄4+	1/32	
=1578+9/32 =1578.2812					

Convert from Base 2 to Base 8

- Using the fact that 3 binary digits are equivalent to one octal digit.
- Eg1. Convert 1001110011
- Group the bits in 3s beginning with the least significant bit
- 001 001 110 011
- Convert the individual groups to base 10.

• Ie
$$001 = 1$$

- 001 = 1
- 110 = 6
- 011 = 3

Therefore 1001110011_2 equivalent to 1163_{10}

Convert from Base 2 to Base 8

- Eg2. Convert 1110011.01101₂
- Group the bits in 3s beginning from the decimal point
- 001 110 011.011 010₂
- Ie 001 = 1
 - 110 = 6
 - 011 = 3
 - 011=3
 - 010 =2
- Therefore 1110011.01101₂ = 163.32₁₀

Convert from Base 8 to Base 2

- Using the similar fact that 3 binary digits are equivalent to one octal digit and convert individual digits to base 2 and form groups of 3.
- Eg 1 convert 6752₈ to base 2
- 6 = 110
- 7 = 111
- 5 = 101
- 2 = 010
- Therefore 6752₈= 110111101010₂

Convert from Base 8 to Base 2

- Eg. 2, Convert 435.465₈ to base 2
- 4 = 100
- 3 = 011
- 5 = 101
- 4=100
- 6 = 110
- 5 = 101
- Therefore 435.465₈ = 100011101.100110101₂

Convert from Base 2 to Base 16

- Using the fact that 4 binary digits are equivalent to one hex digit.
- Eg1. Convert 100111001111
- Group the bits in 4s beginning with the least significant bit.
- 1001 1100 1111
- 1001 = 9
- 1100 = 12 = C
- 1111 = 15 =F
- Therefore = $100111001111_2 = 9CF_{16}$

Convert from Base 2 to Base 16

- Eg2. Convert 111001111.01110101₂
- $\bullet\,$ Group the bits in 4s beginning from the decimal point
- 111001111.01110101₂
- 0001 1100 1111. 0111 0101
- 0001 = 1
- 1100 = 12 = C
 1111 = 15 = F
- 1111 = 15 = 1• 0111 = 7
- 0111 = 7• 0101 = 5
- 0101 .
- Therefore $111001111.01110101_2 = 1$ CF.75₁₆