

# NUMBER SYSTEMS

## BINARY

1. Convert the binary number  $101_2$  to decimal:  $4 + 1 = 5$
2. Convert the binary number  $1010_2$  to decimal:  $8 + 2 = 10$
3. How are the two questions above related?

**1010 is twice as much of 101**

4. Convert the binary number  $10101_2$  to decimal: **21**
5. How are questions 2 and 4 related?

**Twice as much plus one**

6. Convert the binary number  $101011_2$  to decimal: **43**
7. Describe a program that calculates the decimal equivalent of any binary number:

**(1) Division method**

**(2) Subtraction method**

8. Convert the decimal number  $11_{10}$  to binary: **1011**
9. Convert the decimal number  $116_{10}$  to binary: **1110100**

## HEXADECIMAL

10. Convert the hexadecimal numbers  $C_{16}$ ,  $D_{16}$ , and  $E_{16}$  to binary:

**These are twelve, thirteen, fourteen, which are 1100, 1101, 1110**

11. Express the hexadecimal number  $CODE_{16}$  as a sum of 4 terms in decimal: (i.e.  $\_\_ \cdot 16^3 + \_\_ \cdot 16^2 + \dots$ )

**Note that  $16 = 2^4$ ,  $16^3 = 2^{12}$  and X2 shifts us left by one position.**

**CODE is  $12 \times 16^3 + 0 \times 16^2 + 13 \times 16^1 + 14 \times 16^0$**

12. Convert the hexadecimal number  $CODE_{16}$  to binary:

**1100 0000 1101 1110**

13. Convert the binary number:  $100100110_2$  to hexadecimal:

**126**

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## BITWISE OPERATORS

14. What is the value of  $1010_2 \mid 110_2$ ?      **1110**
15. What is the value of  $1010_2 \& 110_2$ ?      **10**
16. What is the value of  $1010_2 \wedge 110_2$ ?      **1100**
17. What is the value of  $1010_2 \ll 10_2$ ?      **101000**
18. What is the value of  $1010_2 \gg 10_2$ ?      **10**
19. What is the value of  $C05126_{16} \wedge CBE245_{16} \wedge C05126_{16}$ ?

**CBE245** - Since the order of inputs to xor doesn't matter, this equals  $C05126_{16} \wedge C05126_{16} \wedge CBE245_{16}$ . Since anything xor'ed with itself is 0, this is  $0 \wedge CBE245_{16} = CBE245_{16}$

## TWO'S COMPLEMENT

20. What is the complement of  $0101\ 0000\ 1100\ 1111_2$ ?  
**1010 1111 0011 0000**
21. What is the 16-bit two's complement binary representation of the decimal number  $116_{10}$ ?  
**0000 0000 0111 0100**
22. What is the 16-bit two's complement binary representation of the decimal number  $-116_{10}$ ?  
**First complement the bits of +116, then add one, giving 1111 1111 1000 1100**
23. What is the 16-bit two's complement hexadecimal representation of the decimal number  $-116_{10}$ ?  
**F F 8 C**
24. What is the decimal representation of the 16-bit two's complement hexadecimal number  $FFFE_{16}$ ?  
**1111 1111 1111 1110: - note left most bit is a 1, so this is a negative number**  
**0000 0000 0000 0001 + - complement**  
**1 - add 1**  
**0000 0000 0000 0010 - equals 2**

**So the original decimal number must -2**

## CHALLENGE

25. Convert the binary numbers  $0.1_2$  and  $0.01_2$  to decimal:

**In decimal these are  $10^{-1}$  and  $10^{-2}$ . In binary these are likewise  $2^{-1} = 1/2$  and  $2^{-2} = 1/4$**