EC1001: Digital Circuits
SOLUTIONS: Assignment-1_Chapter1

1. **What is the exact number of bytes in a system that contains (a) 16K bytes, (b) 32M bytes, and (c) 2G bytes?**

   Solution:
   (a) 16K bytes = 16×2^{10} = 16384 bytes
   (b) 32M bytes = 32×2^{20} = 33554432 bytes
   (c) 2G bytes = 2×2^{30} = 2147483648 bytes

2. **What is the largest binary number that can be expressed with 16 bits? What are the equivalent decimal, octal and hexadecimal numbers?**

   Solution:
   $(1111\ 1111\ 1111\ 1111)_2 = (65535)_{10} = (177777)_8 = (FFFF)_{16}$

3. **Convert the decimal number 253 to binary in two ways: (a) convert directly to binary; (b) convert first to hexadecimal and then from hexadecimal to binary. Which method is faster?**

   Solution:
   (a) Results of repeated division by 2 (quotients are followed by remainders in brackets):

   253_{10} = 126(1); 63(0); 31(1); 15(1);7(1); 3(1); 1(1);0(1)
   Answer: 1111_1101_2

   (b) Results of repeated division by 16 (quotients are followed by remainders in brackets):

   253_{10} = 15(13); 0(15)
   Answer: $FD_{16} = 1111\_1101_2$
   Method (b) is faster since the number of steps for repeated division is much less.

4. **Convert the following binary numbers to hexadecimal and to decimal: (a) 1.00011, (b) 1000.11. Explain why the decimal answer in (b) is 8 times that in (a).**

   Solution:
   (a) $1.00011_2 = 0001.0001\ 1000_2 = 1.18_{16} = 1 + \frac{1}{16} + \frac{8}{256} = 1.09375_{10}$

   (b) $1000.11_2 = 1000.1100_2 = 8.C_{16} = 8 + \frac{12}{16} = 8.75_{10}$

   Reason: If we left shift 1.00011_2 by three places, we get 1000.11_2.
   Hence the value of 1000.11_2 is $2^3 = 8$ times more.

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5. **(a) Find the 16's complement of CAD9.**
   (b) Convert CAD9 to binary.
   (c) Find the 2's complement of the result in (b).
   (d) Convert the answer in (c) to hexadecimal and compare with the answer in (a).

Solution:

(a) $(CAD9)_{16}$

16's comp: $(3527)_{16}$

(b) $(CAD9)_{16} = (1100\ 1010\ 1101\ 1001)_2$

(c) 1100 1010 1101 1001

1's comp: 0011 0101 0010 0110

2's comp: 0011 0101 0010 0111

(d) 0011 0101 0010 0111

$= (3527)_{16}$

(a) and (d) both are same.

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6. **If the numbers $(+9{,}081)_{10}$ and $(+954)_{10}$ are in signed magnitude format, their sum is $(+10{,}035)_{10}$ and requires five digits and a sign. Convert the numbers to signed-10'scomplement form and find the following sums:**
   (a) (+9,081) + (+954) **(b) (+9,081) + (–954)**
   (c) (–9,081) + (+954) **(d) (–9,081) + (–954)**

   Solution:

   $+9081 \rightarrow 009081$
   $-9081 \rightarrow 990918$ (9's comp)
   $-9081 \rightarrow 990919$ (10's comp)

   $+954 \rightarrow 000954$
   $-954 \rightarrow 999045$ (9's comp)
   $-954 \rightarrow 999046$ (10's comp)

   (a) $(+9081) + (954) = 009081 + 000954$
   $= 010035$

   (b) $(+9081) + (-954) = 009081 + 999046$
   $= 1\ 008127$
   drop

   (c) $(-9081) + (+954) = 990919 + 000954$
   $= 991873 \Rightarrow -8127$

   (d) $(-9081) + (-954) = 990919 + 999046$
   $= 1\ 989965 \Rightarrow -10035$
   drop

7. **Convert decimal +49 and +29 to binary, using the signed-2's-complement representation and enough digits to accommodate the numbers. Then perform the binary equivalent of (+29) + (-49), (-29) + (+49), and (-29) + (-49). Convert the answers back to decimal and verify that they are correct.**

   Solution:

00011101	(+29)	11100011	(–29)	11100011	(–29)
11001111	(–49)	00110001	(+49)	11001111	(–49)
11101100	**(–20)**	**$\cancel{1}$00010100**	**(+20)**	**$\cancel{1}$10110010**	**(–78)**

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8. Represent the unsigned decimal numbers 609 and 516 in BCD, and then show the steps necessary to form their sum.

Solution:

BCD of 609	=	0110	0000	1001	
BCD of 516	=	0101	0001	0110	
	+				
Binary Sum	=	1011	0001	1111	
Add 6	=	110		110	
BCD Sum	=	1 0001	0010	0101	= 1125

9. Assign a binary code in some orderly manner to the 52 playing cards. Use the minimum number of bits.

Solution:

For a deck with 52 cards, we need 6 bits ($2^5 = 32 < 52 < 64 = 2^6$). Let the msb's select the suit (e.g., diamonds, hearts, clubs, spades are encoded respectively as 00, 01, 10, and 11. The remaining four bits select the "number" of the card. Example: 0001 (ace) through 1011 (9), plus 101 through 1100 (jack, queen, king). This a jack of spades might be coded as 11 1010. (Note: only 52 out of 64 patterns are used.)

10. The state of a 12-bit register is 010101100100. What is its content if it represents
(a) Three decimal digits in BCD?
(b) Three decimal digits in the excess-3 code?
(c) Three decimal digits in the 84-2-1 code?
(d) A decimal number?

Solution:

	0101	**0110**	**0100**
(a) BCD	5	6	4
(b) Excess-3	2	3	1
(c) 84-2-1	3	2	4
(d) Decimal no.	$(1380)_{10}$		