1. Represent the decimal number 516.5 in BCD and Excess-3 codes, respectively. (14%, each 7%)

BCD: 0101 0001 0110.0101

Excess-3: 1000 0100 1001.1000

2. Perform the subtraction on the given unsigned binary numbers using the 2's complement of the subtrahend. If the result is negative, find its 2's complement and affix a minus sign so the answer is provided in unsigned binary representation. (a) 11000 – 10001. (b) 000100 – 101011. (14%, each 7%)

2.

(a) $11000 - 10001 \xrightarrow{\text{signed 2's}} 011000 - 010001$

$\longrightarrow 011000 + 101111$

$$\begin{array}{r} 011000 \\ +\ 101111 \\ \hline 1\underline{000111} \end{array}$$

$\longrightarrow 000111$

$\xrightarrow{\text{unsigned}} 00111$ #

(b) $000100 - 101011 \xrightarrow{\text{signed 2's}} 0000100 - 0101011$

$\longrightarrow 0000100 + 1010101$

$$\begin{array}{r} 0000100 \\ +\ 1010101 \\ \hline 1011001 \end{array}$$

$\longrightarrow 1011001$

$\longrightarrow -0100111$

$\xrightarrow{\text{unsigned}} -100111$ #

3. Generate the Gray code of a total of 8 codes. Write down the process. (12%)

8 codes need 3 bits

1. Set the first one : 000
2. Change the LSB (0→1) or (1→0) : 001
3. Change the left one bit where the rightest 1 : 010
4. Repeat step 2. 3

000
001
011
010
110
111
101
100

#

4. Perform number conversion from one base to another base. For fractional part, truncate the numbers to the first digit after the radix point. (a) $(67.5)_{10} = (?)_2$. (b) $(10111.0111)_2 = (?)_{10}$. (c) $(724.3)_8 = (?)_{16}$. (15%, each 5%)

(a) $(67.5)_{10} = (1000011.1)_2$

$2 \,|\, 67$ ... 1
$2 \,|\, 33$ ... 1
$2 \,|\, 16$ ... 0
$2 \,|\, 8$ ... 0
$2 \,|\, 4$ ... 0
$2 \,|\, 2$ ... 0
1

1000011

$0.5 \times 2 = \underbrace{1}.0$

(b) $(10111.0111)_2 = (23.4)_{10}$

$= 1 \cdot 2^4 + 1 \cdot 2^2 + 1 \cdot 2^1 + 1 \cdot 2^0 + 1 \cdot 2^{-2} + 1 \cdot 2^{-3} + 1 \cdot 2^{-4}$

$= 23.4375$

$\Rightarrow 23.4$

(c) $(724.3)_8$

$= (\underline{1}\,\underline{1101}\,\underline{0100}.\underline{011})_2 = (1D4.6)_{16}$

5. Perform the following arithmetic operation and represent the results as 5-bit 2's-complement signed numbers. In (a), the numbers are unsigned binary numbers. In (b), the numbers are 2's-complement signed numbers. In (c), the numbers are sign-magnitude signed numbers. Indicate whether overflow occurs in each case. (21%, each 7%)

   (a) 00111 – 1101

   (b) 1011 – 10110

   (c) 01101 + 10100

(a)

$$\begin{array}{r} {\scriptstyle 11} \\ 00111 \\ +\ 10011 \\ \hline 11010 \end{array}$$

no overflow

$(11010)_{2's}$

(b)

$10110_{2's} \rightarrow 01010_{2's}$

$$\begin{array}{r} 11011 \\ +\ 01010 \\ \hline \ast\,00101 \end{array}$$

no overflow

$(00101)_{2's}$

(c)

$10100_{\text{signed}} \rightarrow -0100_{\text{unsigned}} \rightarrow 11100_{2's}$

$$\begin{array}{r} 01101 \\ +\ 11100 \\ \hline \ast\,01001 \end{array}$$

no overflow

$(01001)_{2's}$

6. Consider the function $F(x, y, z) = ((x'y)'x'(zx)'(xy'+xz'))'$. (a) Apply DeMorgan's theorem to the function $F(x, y, z)$ that removes the complement outside the braces. (b) Write the truth table of $F(x, y, z)$. (c) Draw the logic diagram of $F(x, y, z)$. (24%, each 8%)

6.

(a)

$$F(x, y, z) = ((x'y)'x'(zx)'(xy'+xz'))'$$

$$= x'y + x + xz + (xy'+xz')'$$

$$= x'y + x + x' + yz$$

$$= 1$$

(b)

x	y	z	F
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(c)