1. 林彥岑

1.

1 byte = 8 bits

$1\,K = 2^{10} = 1024$

$1\,G = 2^{30} = 1024^3 = 1073741824$

(a) $64\,K$ bytes $= 64 \cdot 1024 \cdot 8$ bits

$= 524288$ bits #

(b) $1.5\,G$ bytes $= 1.5 \cdot 1024^3 \cdot 8$ bits

$= 12884901888$ bits #

2.呂政和

2. (36%) Convert the following numbers (all unsigned) from the given base to other three bases listed in the table (to the 4[th] digit after radix point):

| Decimal | Binary | Octal | Hexadecimal |
|---|---|---|---|
| 53.217 | ? (1) | ? (2) | ? (3) |
| ? (4) | 1011.1101 | ? (5) | ? (6) |
| ? (7) | ? (8) | 48.37 | ? (9) |
| ? (10) | ? (11) | ? (12) | D9.1A |

(1) Decimal 53.217 ⟶ Binary 110101.0011

整數：除 2 取余

$53_{(10)} \rightarrow 110101$

2 | 53
2 | 26 …… 1
2 | 13 … 0
2 | 6 … 1
2 | 3 … 0
1 … 1

小數：乘 2 取整

$(0.217 - 0) \times 2 = 0.434$ … 0
$(0.434 - 0) \times 2 = 0.868$ … 0
$(0.868 - 0) \times 2 = 1.736$ … 1
$(1.736 - 1) \times 2 = 1.472$ … 1
$(1.472 - 1) \times 2 = 0.944$ … 0

$0.217_{(10)} \rightarrow 0.00110\ldots \cong 0.0011$

∴ 53.217 = 110101.0011

(2)

$(110101)_2 = (65)_8$

$0.217 \times 8 = 1.736 \ldots \boxed{1}$

$(1.736-1) \times 8 = 5.888 \ldots \boxed{5}$

$(5.888-5) \times 8 = 7.104 \ldots \boxed{7}$

$(7.104-7) \times 8 = 0.832 \ldots \boxed{0}$

$\Rightarrow (53.217)_{10} = (65.157)_8$

(3)

$(110101)_2 = (35)_{16}$

$0.217 \times 16 = 3.472 \ldots \boxed{3}$

$(3.472-3) \times 16 = 7.552 \ldots \boxed{7}$

$(7.552-7) \times 16 = 8.832 \ldots \boxed{8}$

$(8.832-8) \times 16 = 13.312 \ldots \boxed{d}$

$\Rightarrow (53.217)_{10} = (35.378d)_{16}$

(4) Binary $1011.1101_2 \longrightarrow$ Decimal $11.8125_{(10)}$

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

$= 11.8125$

(5) Binary $1011.1101_2 \longrightarrow$ Octal $13.64_{(8)}$

$\underbrace{001}_{1}\ \underbrace{011}_{3}\ .\ \underbrace{110}_{6}\ \underbrace{100}_{4}$

(6) Binary $1011.1101_2 \longrightarrow$ Hex $b.d_{(16)}$

$\underbrace{1011}_{b}\ .\ \underbrace{1101}_{d}$

(8) Octal $48.37 \longrightarrow$ Binary

因為在8進制，數到8要進位，因此沒有答案。

(7) (9) 同理，無解

(11) Hex $D9.1A_{16} \longrightarrow$ Binary 11011001.00011010

D 9 . 1 A

1101 1001 . 0001 1010

(10) $(D9.1A)_{16} = 13\times16^{1} + 9\times16^{0} + 1\times16^{-1} + 10\times16^{-2}$

$= (217.1015625)_{10}$

$\cong (217.1015)_{10}$

(12)

$(11011001)_2 = (331)_8$

$0.1015625 \times 8 = 0.8125 \quad \ldots \quad 0$

$(0.8125 - 0) \times 8 = 6.5 \quad \ldots \quad 6$

$(6.5 - 6) \times 8 = 4 \quad \ldots \quad 4$

$\Rightarrow (D9.1A)_{16} = (331.064)_8$

3.陳謙謙

紅色為補位(sign bit)，綠色為補位(防止overflow)，藍色為進位

(1)

+37: 100101 -> 0100101

+62: 111110 -> 0111110

(2)

+37: 100101 -> 0100101

-62: (+62) = 0111110 -> 2’ s complement: 1000001+1 = 1000010

-37: (+37) = 0100101 -> 2’ s complement: 1011010+1 = 1011011

(+37)+(-62) -> 0100101 + 1000010

  00100101
<u>+ 11000010</u>
  11100111

11100111 -> 2’ s complement: 00011000 + 1 = 00011001 = (+25) => 11100111 為 (-25) 的表示式

(-37)+(-62) -> 1011011 + 1000010

```
  1    1
  11011011
+ 11000010
  10011101
```

10011101 -> 2’ s complement: 01100010 + 1 = 01100011 = (+99) => 10011101 為 (-99) 的表示式

4.徐浩庭

4. 紅色為補位 藍色為進位

(a)

```
   1 1  1 1  1
   0 0  1 0 1 1 0
+  1 1  0 1 1 1 1
   0 0  0 0 1 0 1
```

(b)

```
              1 1
   0 0  0 0 1 1 0 1
+  1 1  0 1 0 1 1 0
   1 1  1 0 0 0 1 1
```

5.吳東霖

By looking up the corresponding characters in ASCII table,

we can find out that N = 78, T = 84, H = 72, U = 85,

E = 69, C = 67, S = 83 (all in decimal).

Then convert everything into binary

⇒ N = 1001110, T = 1010100, H = 1001000, U = 1010101

E = 1000101, C = 1000011., S = 1010011

Check whether the number of "1" in each character is a even number.

If so, add "0" to MSB, otherwise add "1".

| N | T | H | U |
|---|---|---|---|
| ⇒ 01001110 | 11010100 | 01001000 | 01010101 |
| E | E | C | S |
| 11000101 | 11000101 | 11000011 | 01010011 |

6.林致佑

## Binary Codes for Decimal Numbers

| Decimal Digit | BCD 8421 | 2421 | Excess-3 | 8, 4, −2, −1 |
|---|---|---|---|---|
| 0 | 0000 | 0000 | 0011 | 0000 |
| 1 | 0001 | 0001 | 0100 | 0111 |
| 2 | 0010 | 0010 | 0101 | 0110 |
| 3 | 0011 | 0011 | 0110 | 0101 |
| 4 | 0100 | 0100 | 0111 | 0100 |
| 5 | 0101 | 1011 | 1000 | 1011 |
| 6 | 0110 | 1100 | 1001 | 1010 |
| 7 | 0111 | 1101 | 1010 | 1001 |
| 8 | 1000 | 1110 | 1011 | 1000 |
| 9 | 1001 | 1111 | 1100 | 1111 |
| | 1010 | 0101 | 0000 | 0001 |
| Unused bit combi-nations | 1011 | 0110 | 0001 | 0010 |
| | 1100 | 0111 | 0010 | 0011 |
| | 1101 | 1000 | 1101 | 1100 |
| | 1110 | 1001 | 1110 | 1101 |
| | 1111 | 1010 | 1111 | 1110 |

a. $(1001\ 0101)_{BCD} = (95)_{10}$

b. $(1001\ 0101)_{Excess\text{-}3} = (62)_{10}$

c. 8-bit unsigned number

$\Rightarrow (2^7 + 2^4 + 2^2 + 2^0)_{10} = (149)_{10}$

d. 8-bit signed number

$\Rightarrow (-2^7 + 2^4 + 2^2 + 2^0)_{10} = -(107)_{10}$

7. (呂依凡)

$$\lceil \log_2 35 \rceil = 6$$

$$2^5 = 32 < 35 < 2^6 = 64$$

$$\rightarrow \textit{we need at least } 6 \textit{ bits.}$$

8. (呂依凡)

For 12 codes

We need 12 codes

→ we need at least $\lceil \log_2 12 \rceil = 4\ bits.$

→ MSB of the first $\frac{12}{2} = 6$ codes are 0, and that of the others are 1.

| original code{$d_3 d_2 d_1 d_0$} | gray code{$g_3$} |
| --- | --- |
| 0000 | 0 |
| 0001 | 0 |
| 0010 | 0 |
| 0011 | 0 |
| 0100 | 0 |
| 0101 | 0 |
| 0110 | 1 |
| 0111 | 1 |
| 1000 | 1 |
| 1001 | 1 |
| 1010 | 1 |
| 1011 | 1 |

$$g_x = \begin{cases} 0, \ when \ d_{x+1} \ and \ d_x \ contain \ even \ number \ of \ 1s \\ 1, \ when \ d_{x+1} \ and \ d_x \ contain \ odd \ number \ of \ 1s \end{cases}$$
$$, where \ x = \{2, 1, 0\}$$

Then we have,

| original code{$d_3d_2d_1d_0$} | gray code{$g_3g_2g_1g_0$} |
|---|---|
| 0000 | 0000 |
| 0001 | 0001 |
| 0010 | 0011 |
| 0011 | 0010 |
| 0100 | 0110 |
| 0101 | 0111 |
| 0110 | 1111 |
| 0111 | 1110 |
| 1000 | 1010 |
| 1001 | 1011 |
| 1010 | 1001 |
| 1011 | 1000 |

鏡射

For 10 codes:

We need 10 codes

$\rightarrow$ we need at least $\lceil \log_2 10 \rceil = 4\ bits$.

$\rightarrow$ MSB of the first $\frac{10}{2} = 5$ codes are 0, and that of the others are 1.

| original code{$d_3d_2d_1d_0$} | gray code{$g_3$} |
|---|---|
| 0000 | 0 |
| 0001 | 0 |
| 0010 | 0 |
| 0011 | 0 |
| 0100 | 0 |
| 0101 | 1 |
| 0110 | 1 |
| 0111 | 1 |
| 1000 | 1 |
| 1001 | 1 |

$$g_x = \begin{cases} 0, & when\ d_{x+1}\ and\ d_x\ contain\ even\ number\ of\ 1s \\ 1, & when\ d_{x+1}\ and\ d_x\ contain\ odd\ number\ of\ 1s \end{cases}$$
$$, where\ x = \{2, 1, 0\}$$

Then we have,

| original code{$d_3d_2d_1d_0$} | gray code{$g_3g_2g_1g_0$} |
|---|---|
| 0000 | 0000 |
| 0001 | 0001 |
| 0010 | 0011 |
| 0011 | 0010 |
| 0100 | 0110 |
| 0101 | 1110 |
| 0110 | 1010 |
| 0111 | 1011 |
| 1000 | 1001 |
| 1001 | 1000 |

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