

Lab 1

Question 1.

$$1) \ 88_{10} = 1011000_2$$

| | | |
|---|----|---|
| 0 | 88 | 2 |
| 0 | 44 | 2 |
| 0 | 22 | 2 |
| 1 | 11 | 2 |
| 1 | 5 | 2 |
| 0 | 2 | 2 |
| 1 | | |

$$2) \ 444.1875_{10} = 110111100.0011_2$$

| | | |
|---|-----|---|
| 0 | 444 | 2 |
| 0 | 222 | 2 |
| 1 | 111 | 2 |
| 1 | 55 | 2 |
| 1 | 27 | 2 |
| 1 | 13 | 2 |
| 0 | 6 | 2 |
| 1 | 3 | 2 |
| 1 | | |

$$0.1875 \times 2 = 0.375 \quad 0$$

$$0.375 \times 2 = 0.75 \quad 0$$

$$0.75 \times 2 = 1.5 \quad 1$$

$$0.5 \times 2 = 1.0 \quad 1$$

$$3) \ 56_8 = 101110_2$$

each octal digit = 3 binary digits

$$5_8 = 101_2$$

$$6_8 = 110_2$$

$$4) \ 2E4B_{16} = 0010\ 1110\ 0100\ 1011_2$$

each hex digit = 4 binary digits

$$2_{16} = 0010_2 \quad 4_{16} = 0100_2$$

$$E_{16} = 1110_2 \quad B_{16} = 1011_2$$

$$5) \ (1000 \ 0101)_{BCD} = 101\ 0101_2$$

$$1000 = 8_{10} \quad 0101 = 5_{10} \quad 85_{10}$$

| | | |
|---|----|---|
| 1 | 85 | 2 |
| 0 | 42 | 2 |
| 1 | 21 | 2 |
| 0 | 10 | 2 |
| 1 | 5 | 2 |
| 0 | 2 | 2 |
| | 1 | |

6) 'Z' ASCII = 01011010,
8 bits

ASCII value of 'Z' = 90₁₀

| | | |
|---|----|---|
| 0 | 90 | 2 |
| 1 | 45 | 2 |
| 0 | 22 | 2 |
| 1 | 11 | 2 |
| 1 | 5 | 2 |
| 0 | 2 | 2 |
| | 1 | |

1011010 7 bits

adding zero at the front makes it 8 bits

7) 'z' ASCII = 01111010_2

ASCII value of 'z' = 122_{10}

| | | |
|---|-----|---|
| 0 | 122 | 2 |
| 1 | 61 | 2 |
| 0 | 30 | 2 |
| 1 | 15 | 2 |
| 1 | 7 | 2 |
| 1 | 3 | 2 |
| | 1 | |

1111010
7 bits

01111010
8 bits

8) ACK (signal ASCII) = 00000110_2

ACK in ASCII = 6_{10}

| | | |
|---|---|---|
| 0 | 6 | 2 |
| 1 | 3 | 2 |
| | 1 | |

110_2

00000110 8-bit form

Question 2.

1) 101011001001_2

a. $101 \quad 011 \quad 001 \quad 001$

$$101_2 = 5_8 \quad 001_2 = 1_8$$

$$011_2 = 3_8 \quad 001_2 = 1_8$$

$$\text{So } (101011001001)_2 = \underline{\underline{5311_8}}$$

Hex.

1010 1100 1001

$$1010_2 = A_{16}$$

$$1100_2 = C_{16}$$

$$1001_2 = 9_{16}$$

HEX: AC9₁₆

b.

11109876543210

$$101011001001 = \frac{1}{2} + 0 \cdot \frac{1}{2} +$$

$$+ 1 \cdot \frac{1}{2} + 0 \cdot \frac{1}{2} + 1 \cdot \frac{1}{2} + 1 \cdot \frac{1}{2} + 0 \cdot \frac{1}{2} + 0 \cdot \frac{1}{2} +$$

$$+ 1 \cdot \frac{1}{2} + 0 \cdot \frac{1}{2} + 1 \cdot \frac{1}{2}^0 = 2048 +$$

$$+ 512 + 128 + 64 + 8 + 1 = 2761$$

10

Decimal to octal

| | | |
|---|------|---|
| 1 | 2761 | 8 |
| 1 | 345 | 8 |
| 3 | 43 | 8 |
| 5 | 5 | 8 |
| | 0 | |

5311_8 matches
1a

Decimal to hex

| | | |
|----|------|----|
| 9 | 2761 | 16 |
| 12 | 172 | 16 |
| 10 | 10 | 16 |

0

HEX: AC 9₁₆

matches 19

2) $(AB)_{16}$ in base-2, base-8
base-10

Base - 2:

$$A_{16} = 1010_2 \quad B_{16} = 1011_2$$

$$\text{So } \underline{AB_{16} = 1010\ 1011_2}$$

Base - 8:

0 1 0 1 0 1 0 1 1 group from bin.

$$010_2 = 2_8$$

$$101_2 = 5_8 \quad \text{Octal: } \underline{\underline{253}}_8$$

$$011_2 = 3_8$$

Base - 10:

$$A \times 16^1 + B \times 16^0 = 10 \times 16 + 11 =$$

$$= 160 + 11 = \underline{\underline{171}}_{10}$$

3)

a) Magnitude $1_{10} = 001_2$ in 3 bits
positive = 0, negative = 1 - sign bit

-1_{10} has negative so

in 4-bit sign - magnitude
is $\underline{\underline{1001}}_2$

b) 0000 0001 positive 1 in 8 bits

1111 1110₂ 1's complement

c)

0000 0000 0000 0001 positive 1
in 16 bits

+ 1111 1111 1111 1110 1's compl.

1111 1111 1111 1111 2's compl.
 2

2. $(5678)_{10}$

$$9-5=4 \quad 9-6=3 \quad 9-7=2 \quad 9-8=1$$

9's complement = 4321

10's complement = 9's + 1

$$\begin{array}{r} + 4321 \\ \hline 1 \\ \hline 4322 \end{array}$$

9's complement: 4321

10's complement: 4322

4)

1. $4CG4_{19}$ to base -10 and 13

Base -10: 12

$$4 \cdot 19^3 + C \cdot 19^2 + G \cdot 19^1 + 4 \cdot 19^0 =$$

$$= 4 \cdot 6859 + 12 \cdot 361 + 16 \cdot 19 + 4 =$$

$$= 27436 + 4332 + 304 + 4 = 32076_{10}$$

$$\underline{4CG4}_{19} = 32076_{10}$$

Base - 13:

| | | |
|----|-------|----|
| 5 | 32076 | 13 |
| 10 | 2467 | 13 |
| 7 | 189 | 13 |
| 1 | 14 | 13 |
| 1 | 1 | 13 |
| | 0 | |

A

$$\underline{4CG4}_{19} = 32076_{10} = 117A5_{13}$$

2.

8-bit 2's complement int.

Most negative: 10000000_2

Most positive: 01111111_2

$$10000000_2 = 127 + 1 = -128_{10}$$

$$01111111_2 = +127_{10}$$

5.

1) Decimal BCD

| | |
|---|------|
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |

| | |
|----|-----------|
| 8 | 1000 |
| 9 | 1001 |
| 10 | 0001 0000 |
| 11 | 0001 0001 |
| 12 | 0001 0010 |
| 13 | 0001 0011 |
| 14 | 0001 0100 |
| 15 | 0001 0101 |

2)

$$\begin{array}{r}
 \text{d)} \quad 1001 \quad 0100 \\
 + \quad 0110 \quad 0111 \\
 \hline
 \end{array}
 \qquad
 \begin{array}{r}
 + \quad 94 \\
 + \quad 67 \\
 \hline
 161
 \end{array}$$

$$\begin{array}{r}
 + \quad 1111 \quad 1011 \\
 \hline
 \end{array}$$

$$\begin{array}{r}
 \hline
 \end{array}$$

$$\begin{array}{r}
 \hline
 \end{array}$$

1 6 1

Answer: 0001 0110 0001

$$\begin{array}{r}
 \text{b)} \quad 1001 \quad 1000 \\
 + \quad 0001 \quad 0010 \\
 \hline
 \end{array}$$

$$\begin{array}{r}
 + \quad 1010 \quad 1010 \\
 0110 \quad 0110 \\
 \hline
 \end{array}$$

$$\begin{array}{r}
 \boxed{0001} \quad \boxed{0001} \quad \boxed{0000} \\
 \textcolor{blue}{1} \qquad \textcolor{blue}{1} \qquad \textcolor{blue}{0}
 \end{array}$$

$$\begin{array}{r}
 + \quad 98 \\
 12 \\
 \hline
 110
 \end{array}$$

Answer: 0001 0001 0000