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Assignment : 1
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DIGITAL LOGIC & DESIGN

Assignment 1

Q1: what is the weight of 7 in 1799_{10}?

Sol

writing in weighted form

$(1 \times 10^3) + (7 \times 10^2) + (9 \times 10^1) + (9 \times 10^0)$

1000 + 700 + 90 + 9

The weight of 7 in 1799_{10} is 100.

Q2 Give the value of each digit in $(5436)_{10}$?

Sol write in weighted form

$(5 \times 10^3) + (4 \times 10^2) + (3 \times 10^1) + (6 \times 10^0)$

5000 400 30 6

Value of 5 = 5000
value of 4 = 400
value of 3 = 30
value of 6 = 6

Q 3: Convert the following.

(a) $11111111_{(2)} = (?)_{10}$

Sol Using weighted notation

$(1\times10^{7})+(1\times10^{6})+(1\times10^{5})+(1\times10^{4})+(1\times10^{3})+(1\times10^{2})+(1\times10^{1})+(1\times10^{0})$

128 64 32 16 8 4 2 1

255_{10} Ans.

(b) $127_{10} = (?)_{2}$

Sol Using Repeated division by 2.

2	127	0
2	63	1
2	31	1
2	15	1
2	7	1
2	3	1
2	1	1

$= (01111111)_2$ Ans

(c) $45.25_{(10)} = (?)_2$

Sol Using Repeated division for whole number 45

2	45	
2	22	1
2	11	0
2	5	1
2	2	1
2	1	0

$45_{10} = (101101)_2$

Using repeated ~~mom~~ multiplication for decimal part.

$0.25 \times 2 = 0.50 \rightarrow 0$
$0.50 \times 2 = 1.00 \rightarrow 1$

$= 45.25_{(10)} = (101101.01)_2$ Ans

(d) $10000000.1010_{(2)} = (?)_{10}$

Sol Using weighted notation

$(1 \times 2^7) + (1 \times 2^{-1}) + (1 \times 2^{-3})$ (ignoring 0s)

$128 + 0.5 + 0.125$

$= 128.625_{(10)}$ Ans.

(e) $4D7F_{(16)} = (?)_{10}$

Sol: Using weighted notation

$(4\times16^3)+(13\times16^2)+(7\times16^1)+(15\times16^0)$

$16384 + 3328 + 112 + 15$

$(19839)_{10}$ Ans.

(f) $128_{(10)} = (?)_{16}$

Sol: Using Repeated division by 16.

16	128	
16	8	0

$128_{(10)} = 80_{(16)}$ Ans.

(g) $3A6F_{(16)} = (?)_2$

Sol: by hex – Binary table

3	A	6	F
0011	1010	0110	1111

$= 0011101001101111_{(2)}$ Ans.

(h) $1100001111100101_{(2)} = (?)_{16}$

Sol Using groups of four.

1100	0011	1110	0101
C	3	E	5

$= C3E5_{(16)}$ Ans

(i) $6173_{(8)} = (?)_{10}$

Sol Using weighted notation.

$(6 \times 8^3) + (1 \times 8^2) + (7 \times 8^1) + (3 \times 8^0)$

$3072 + 64 + 56 + 3$

$61783_{(8)} = 3195_{(10)}$ Ans

(J) $169_{(10)} = (?)_8$

Sol by repeated division of 8

8	169	
8	21	1
8	2	5

$(251)_8$ Ans.

(k) $3740_{(8)} = (?)_2$

Sol Using Oct-Binary table

3	7	4	0
011	111	100	000

$011111100000_{(2)}$ Ans

(l) $1010110001011111_{(2)} = (?)_8$

Sol Using Groups of 3.

001	010	110	001	011	111
1	2	6	1	3	7

$= 126137_{(8)}$ Ans

(M) 2A7D(16) = (?)8

Sol First using hex-Binary table.

2	A	7	D
0010	1010	0111	1101

Now using groups of 3.

000	010	101	001	111	101
0	2	7	1	7	5

~~Ans~~ = 25175(8) Ans

(n) (7503)8 = (?)16

Sol Octal-Binary table first

7	5	0	3
111	101	000	011

Now using groups of 4

1111	0100	0011
F	4	3

F43(16) Ans

(O) $11111111_{(2)} = \pm(?)_{10}$

Sol Using 2's Complement

$$
\begin{array}{rl}
11111111 & \\
00000000 & \text{1's Complement} \\
+ \quad\quad 1 & \text{2's Complement} \\
\hline
00000001 &
\end{array}
$$

Now since signed bit is zero.

$(1 \times 2^0) = +1_{(10)}$ Ans

(P) $-12_{10} = (?)_2$

Sol First finding 12 in binary.

2	12	
2	6	0
2	3	0
2	1	1

$12 = 1100_{(2)}$

Taking 2's Complement.

$$
\begin{array}{rl}
00001100 & \\
11110011 & \text{1's Complement} \\
+ \quad\quad 1 & \text{2's Complement} \\
\hline
11110100_{(2)} &
\end{array}
$$

(Ans)

(q) 156(10) = (?) BCD

Sol Using Deci-BCD table

1 5 6

0001 0101 0110

000101010110 BCD Ans

(r) 100000111 0000 BCD = (?) 10

Sol Using BCD-Deci table

1000 0111 0000

8 7 0

870 (10) Answer

(s) 1001010(2) = (?) Grey

Sol 1 —> + 0 —> + 0 —> + 1 —> + 0 —> + 1 —> + 0

↓ ↓ ↓ ↓ ↓ ↓ ↓

1 1 0 1 1 1 1

= 1101111 Grey Ans

(b) 10101111 grey = (?)2

Sol

1 0 1 0 1 1 1 1

↓ + ↗ ↓ + ↗ ↓ + ↗ ↓ + ↗ ↓ + ↗ ↓ + ↗ ↓ + ↗ ↓

1 1 0 0 1 0 1 0

11001010 (2) Ans

(iv) 0100 0000 = (?) ASCII - Small

Sol

using ASCII table

$(1 \times 2^6) + (1 \times 2^0)$

64 + 1

= 65(10)

65(10) = A ASCII character

(V) 0110 0000 = (?) ASCII capital

Sol Using ASCII table.

$(1 \times 2^6) + (1 \times 2^5)$

64 + 32

= 96(10)

96(10) = (') ASCII

(w) 111000 = (? 111000) Even parity

Sol

For Even parity

111000 = (1 111000) Even parity.

As the number of 1s must be even.

(x) 101101 = (? 101101) odd parity.

For odd parity

101101 = (1 101101) odd parity.

As number of ones must be odd.

Q2. Calculate each of the following

(a) $11110011_{(2)} + 01011111_{(2)}$

Sol

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

Discarded bit

$01010010_{(2)}$ Answer

(i) 10000000 − 01111111

Sol Taking 2's Complement

```
   01111111
   10000000   1's Complement
 +        1   2's Complement
 ----------
   10000001
```

Now

```
   10000000
 + 10000001
 ----------
  100000001
  ↑
Discarded bit
```

00000001 Answer

~~(c) 1100(2) + 10(2)~~

(c) $1100_{(2)} \times 11_{(2)}$

Sol

```
      x 11
      1100
    ------
        00
       00
  + 1111
    11
  --------
  100100      Answer
```

(d) $1100_{(2)} \div 10_{(2)}$

Sol

```
      110
   10) 1100
       10
       ---
        100
         10
        ---
         00
         00
        ---
          x
```

(110 Ans)

(e) $01111111_{(2)} - 00000111_{(2)}$

Sol Taking 2's Complement

```
  00000111
  11111000    1's Complement
+        1
  --------
  11111001    2's Complement
```

Now

```
   1 11111111
     01111111
+    11111001
  -----------
    101111000
```

Discard bit

$01111000_{(2)}$ Ans.

(f) $01101010_{(2)} \times 11110001_{(2)}$

Sol Taking 2's Complement

```
  11110001
  00001110    1's Complement
+        1    2's Complement
  --------
  00001111
```

Now

```
              00001111
              01101010
              00000000
           1000011111x
          00000000xx
         00001111xxx
        00000000xxxx
       00001111xxxxx
      00001111xxxxxx
     00000000xxxxxxx
0000011000110110
```

Taking 2's Complement again.

```
  11000110110
  00111001001   1's Complement
+           1   2's Complement
  00111001010
```

11100101010 Ans

(g) $10001000_{(2)} \div 00100010_{(2)}$

Sol Taking 2's Complement.

```
  00100010
  11011101   1's Complement
         1   2's Complement
  11011110
```

Quotient = 00000000

Substracting devisor from dividend with 2's complement

```
  10001000
+ 11011110
Discard → 101100110
```

Add 1 to quotient = 00000001

Subtracting deviser from first partial remainder

```
  01100110
+ 11011110
Discard → 101000100
```

Add 1 to Quotient = 00000010

Again

```
  01000100
+ 11011110
Discard → 100100010
```

Add 1 to Quotient = 00000011

Again

```
  00100010
+ 11011110
Discard → 100000000
```

Add 1 to quotient = 00000100 Answer

(h) $FC_{16} + AE_{16}$

Sol

$$\begin{array}{r} F\ C \\ +\ A\ E \\ \hline 1\ A\ A \end{array}$$

1 AA ~~AB~~

(i) $F1_{16} - A6_{16}$

Sol Using 2's Complement.

$$\begin{array}{cc} A & 6 \\ \hline 1010 & 0110 \end{array}$$

$$\begin{array}{r} 10100110 \\ +\ 01011001 \\ 1 \\ \hline 01011010 \end{array}$$

2's Complement

F	C
1111	1100

Now.

$$
\begin{array}{r}
1\,1\,1\,1 \\
1\,1\,1\,1\,1\,1\,0\,0 \\
+\,0\,1\,0\,1\,1\,0\,1\,0 \\
\hline
\text{Discard} \rightarrow 1\,0\,1\,0\,1\,0\,1\,1\,0
\end{array}
$$

$\underbrace{0101}_{5}\ \underbrace{0110}_{6}$

56 Ans

(ii) $6D_{16} - 3F_{16}$

Sol Using 2's Complement

3	F
0011	1111

$$
\begin{array}{r}
00111111 \\
+\ 11000000 \\
1 \\
\hline
11000001
\end{array}
$$

2's Complement

6	D
0110	1101

Adding.

$$
\begin{array}{r}
01101101 \\
+\ 11000001 \\
\hline
100101110
\end{array}
$$

Discard → 100101110

0010	1110
2	E

2E Ans

(k) 00010110 BCD + 00010101 BCD

Sol

```
  0001 0110
+ 0001 0101
  0010 1010  → invalid due to (>9)
```

Add 6 to invalid code.

```
  0010 1010
       0110
  0011 0001   Ans
```

Q5: Apply modulo-2 to $1100_2 + 1011_2$

Sol

```
 1101
 1011
 0111   Ans
```

Q6: Apply CRC to the Data bits 10110010 (2) using generator code 1010 (2).

Sol

D = 11010011 (2)
G = 1010
D' = 11010011000 0

Using modulo-2 operation.

$\frac{D'}{G}$ = 110100110000

```
110100110000
1010
 1110
 1010
  1000
  1010
   1011
   1010
     1000
     1010
      100   <- Non-zero
```

Again: by adding remainder to Data bits.

```
110100110100
1010
 1110
 1010
  1000
  1010
   1011
   1010
     1010
     1010
        0
```

hence 110100110100 is Transmitted CRC.

Q 7. Assume that the Code produced in Q 5. incurres an error in the most significant bit. Apply CRC to detect error.

a)

Recieved data = D' = 010100110100

G = 1010

using modulo-2 operation

```
010100110100
1010
1111
1010
 1010
 1010
     0110
     1010
     1100
     1010
      1101
      1010
       1110
       1010
        1000
        1010
          10  -> ≠ 0
```

hence error has occured.