Assignment 1

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1 a) $(345)_{10} \rightarrow (\,)_2$ unsigned

345/2 = 172 1/2
172/2 = 86 0/2
86/2 = 43 0/2
43/2 = 21 1/2
21/2 = 10 1/2
10/2 = 5 0/2
5/2 = 2 1/2
2/2 = 1 0/2
1/2 = 1/2

$(345)_2 \rightarrow (101011001)_2$

b) $(-345)_{10} \rightarrow (\,)_2$ signed 2's complement

$(345)_{10} = (0101011001)_2$
$(-345)_{10} = (1010100110)_2$ 1's complement
$(1010100111)_2$ 2's complement (add 1)

$(-345)_{10} \rightarrow (1010100111)_2$

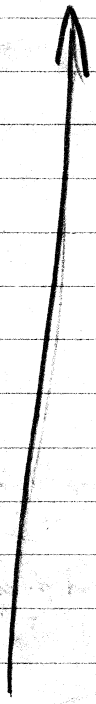
c) $(47488)_{10} \rightarrow (\,)_{16}$ unsigned

47488/16 = 2968 0/16
2968/16 = 185 8/16
185/16 = 11 9/16
11/16 = 0 11/16 (B)

$(47488)_{10} \rightarrow (B980)_{16}$

1 d) $(-36574)_{10} \rightarrow ()_{16}$ Hex signed 1s complement

36574/2 = 18287 0/2
18287/2 = 9143 1/2
9143/2 = 4571 1/2
4571/2 = 2285 1/2
2285/2 = 1142 1/2
1142/2 = 571 0/2
571/2 = 285 1/2
285/2 = 142 1/2
142/2 = 71 0/2
71/2 = 35 1/2
35/2 = 17 1/2
17/2 = 8 1/2
8/2 = 4 0/2
4/2 = 2 0/2
2/2 = 1 0/2
1/2 = 0 1/2



$(36574)_{10} \rightarrow (0000\ 1000\ 1110\ 1110)_2$
$(-36574)_{10} \rightarrow (1111\ 0111\ 0001\ 0010)_2$
AA 1's complement AA
$(-36574)_{10} \rightarrow (F7121)_{16}$ (Groups of 4 to get Hex)

1 e) $(-89911)_{10} \rightarrow (\,)_8$ Signed magnitude Octal

89911 / 8 = 11238 7/8
11238 / 8 = 1404 6/8
1404 / 8 = 175 4/8
175 / 8 = 21 7/8
21 / 8 = 2 5/8
2 / 8 = 0 2/8

$(89911)_{10} \rightarrow (257467)_8$ unpack numbers into groups of 3

$(257467)_8 \Rightarrow (010\,101\,111\,100\,110\,111)_2$ (positive)

$(110\,101\,111\,100\,110\,111)_2$ (negative)

$(-89911)_{10} \rightarrow (657467)_8$ (Groups of 3 to get Octal)

2 a) $(-6.3125)_{10}$

$(6)_{10} \rightarrow (110)_2$

0.3125 × 2 = 0.625
0.625 × 2 = 1.25
0.25 × 2 = 0.5
0.5 × 2 = 1

$(0.3125)_{10} \rightarrow (.0101)_2$
$(6.3125)_{10} \rightarrow (110.0101)_2$
$(110.0101)_2 \Rightarrow (.1100101) \times 2_{10}^{3}$

exp = 16 + 3 = 19

$(-6.3125)_{10}$ -> Signed float

(1 10011 1100101) = $(-6.3125)_{10}$

Sign Exponent Significand

2 b) $(4.10742\ 18\ 75)_{10}$

$(4)_{10} \rightarrow (100)_2$

$0.10742\ 1875 \times 2 = 0.21484375$

$0.21484375 \times 2 = 0.429\ 6875$

$0.429\ 6875 \times 2 = 0.859375$

$0.859\ 375 \times 2 = 1.718\ 75$

$0.71875 \times 2 = 1.4375$

$0.4375 \times 2 = 0.875$

$0.875 \times 2 = 1.75$

$0.75 \times 2 = 1.5$

$0.5 \times 2 = 1$

$(0.107421875)_{10} \rightarrow (.000110111)_2$

$(4.107421875)_{10} \rightarrow (100.000110111)_2$

$(100.000110111)_2 \rightarrow (.100000110111)_2 \times 2^{3}$

zero round down

$exp = 16 + 3 = 19$

$(4.1074\ 2\ 1875)_{10} \Rightarrow$ signed float

$(0\ \ 10011\ \ 10000011)_2 = (4.107421875)_{10}$

Sign Exponent Significand

c) $(-17.59375)_{10}$

$(17)_{10} \rightarrow (10001)_2$

$0.59375 \times 2 = 1.1875$

$0.1875 \times 2 = 0.375$

$0.375 \times 2 = 0.75$

$0.75 \times 2 = 1.5$

$0.5 \times 2 = 1$

$(0.59375)_{10} \rightarrow (.10011)_2$

$(17.59375)_{10} \rightarrow (10001.10011)_2$

$(10001.10011)_2 \rightarrow (.1000110011)_2 \times 2^{5}_{10}$

1 round up

$exp = 16 + 5 = 21$

$(-17.59375)_{10} \Rightarrow$ signed float

$(1\ \ 10101\ \ 10001101)_2 = (-17.59375)_{10}$

Sign exponent Significand

3 a) Polynomial = x^2+x+1 = 111

Data = 11101011

```
        10001011
   111 | 11101011 00
         111
         -------
         0000101
           111
           -----
           0101
            111
            ----
            0100
             111
             ----
             0110
              111
              ---
              001   remainder
```

CRC = 11101011 00 + 1

= 11101011 01

b) Polynomial = x^3+1 = 1001

Data = 1011101

```
        1010111
  1001 | 1011101000
         1001
         -------
         001010
           1001
           -----
           001110
            1001
            ----
            01110
             1001
             ----
             01110
              1001
              ----
              0111
```

CRC = 1011101000 + 111

= 1011101111

4 a) 11101010 using ODD parity

1110_1010_000

pos1 → 10110 → 0
pos2 → 11100 → 0
pos4 → 1101 → 0
pos8 → 1110 → 0

b) 10101110 using EVEN parity

1010_111_00_1_0

pos1 → 00110 → 0
pos2 → 01110 → 1
pos4 → 1111 → 0
pos8 → 1010 → 0

c) 11010011 using ODD parity

1101_0001_1_1_1

pos1 → 11011 → 1
pos2 → 10001 → 1
pos4 → 1001 → 1
pos8 → 1101 → 0

d) 11010011 using EVEN parity

1101_1001_0_1_0_0

pos1 → 11011 → 0
pos2 → 10001 → 0
pos4 → 1001 → 0
pos8 → 1101 → 1

Parity positions on this page and the next were all calculated with the following functions

	Even	Odd
pos1	$\oplus(3,5,7,9,11)$	$\overline{\oplus}(3,5,7,9,11)$
pos2	$\oplus(3,6,7,10,11)$	$\overline{\oplus}(3,6,7,10,11)$
pos4	$\oplus(5,6,7,12)$	$\overline{\oplus}(5,6,7,12)$
pos8	$\oplus(9,10,11,12)$	$\overline{\oplus}(9,10,11,12)$

5 a) 100111011110 using EVEN parity

1001 1 101 1 1 1 0

1011 1 101 1 1 0

↑ corrected

8-bit value
10111011

pos 1 → 01111 → 0 = 0
pos 2 → 00101 → 0 ≠ 1
pos 4 → 1101 → 1 = 1
pos 8 → 1001 → 0 ≠ 1
pos 2 and 8 erroneous
error in 2+8 = 10

b) 111001011000 using ODD parity

1110 0 101 1 000

1110 0 101 0 000

↑ corrected

8-bit value
11101010

pos 1 → 10110 → 0 = 0
pos 2 → 11100 → 0 = 0
pos 4 → 1101 → 0 ≠ 1
pos 8 → 1110 → 0 = 0
pos 4 erroneous
error in 4

c) 010111000101 using ODD parity

0101 1 100 0 1 0 1

0101 1 100 0 1 0 1

no corrections

8-bit value
01011001

pos 1 → 11101 → 1 = 1
pos 2 → 10101 → 0 = 0
pos 4 → 0100 → 0 = 0
pos 8 → 0101 → 1 = 1
no erroneous bits
no bit errors

6

0 0 0 0 0 1 0 1 0 1 1 1 1 1 1 1 = A
0 0 0 0 1 0 1 0 1 0 1 1 1 1 1 1 = B
0 0 0 1 0 1 0 0 1 1 0 1 1 1 1 1 = C
0 0 1 0 1 0 1 0 1 1 1 0 1 1 1 1 = D
0 1 0 1 0 0 0 0 1 1 1 1 0 1 1 1 = E
1 0 1 0 0 0 1 0 1 1 1 1 0 1 1 1 = F
0 1 0 0 0 0 0 0 1 1 1 1 1 1 0 1 = G
1 0 0 0 0 0 0 1 0 1 1 1 1 1 1 0 = H

AB = 6	BC = 6	
AC = 4	BD = 3	← Mimimum Found
AD = 7	BE =	The First eight bits of every
AE = 6	BF =	Code have minimum distance 2
AF = 7	BG =	The Second 8 bits are unique
AG = 4	BH =	across all codes so minimum
AH = 6		distance must be greater than 2
		3 is the smallest number bigger-
D(min) = 3		than 2 so it must be the
		minimum.