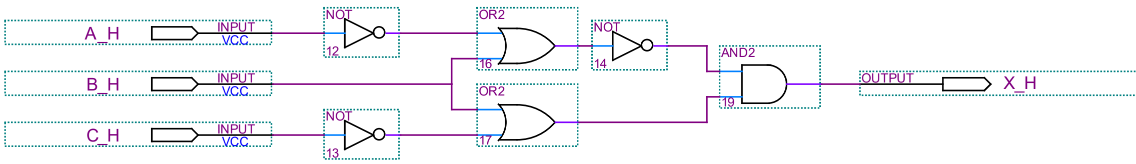
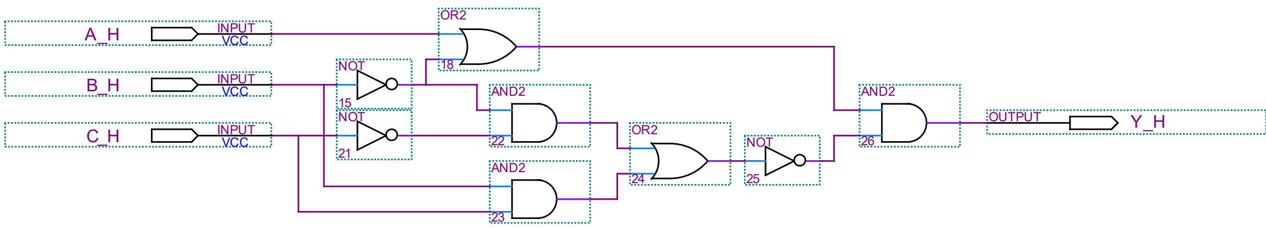
Homework 3 Solutions

Problem 1:

1 a) X = /(/A + B) * (B + /C)

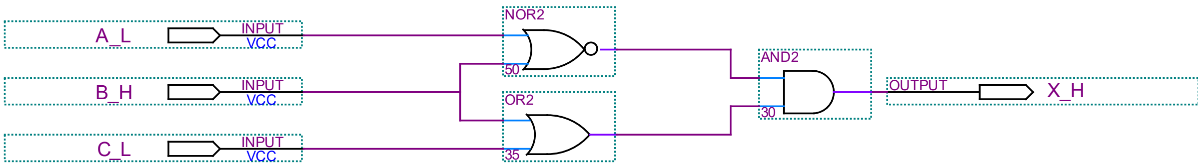


1 b) Y = (A + /B) * /(/B * /C + B * C)

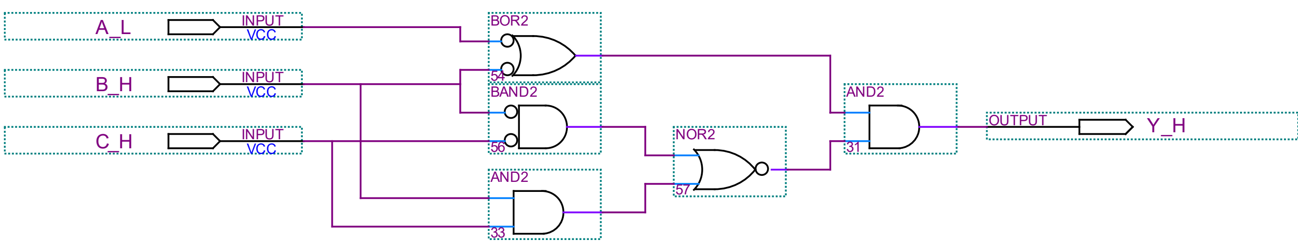


Problem 2:

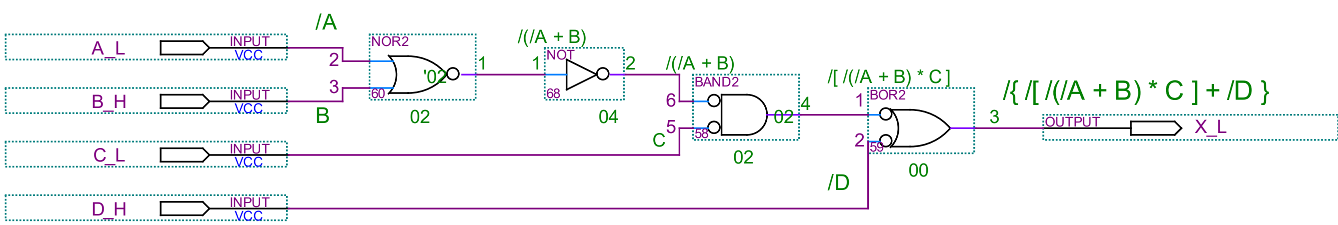
2 a) X = /(/A + B) * (B + /C)



2 b) Y = (A + /B) * /(/B * /C + B * C)



Problem 3:



Problem 4:

a) 12-bit unsigned binary = 1010 1111 1111 = 2048+512+255 = 2815
b) 12-bit sign magnitude = -(512+255) = -767
c) 12-bit 1's complement = -(0101 0000 0000) = -(1024+256) = -1280
d) 12-bit 2's complement = -(0101 0000 0001) = -(1024+256+1) = -1281
e) 12-bit BCD = not a valid BCD number

Homework 3 Solutions

Problem 5:

	3 bit signed	3 bit 1's compl	3 bit 2's compl
000	0	0	0
001	1	1	1
010	2	2	2
011	3	3	3
100	(-)0	-3	-4
101	-1	-2	-3
110	-2	-1	-2
111	-3	(-)0	-1

Problem 6:

```
            1 1001           25
          * 1 0110          *22
          -------------------------
           11 0010           50
          110 01            50
       1 1001               550
       ----------
      10 0010 0110
```

Problem 7:

```
a)     1001 0101          149
     + 0111 1111         +127
     ---------------------------
     1 0001 0100          276

b)   8 bit 2's complement:
      1001 0101         -107
   + 0111 1111          +127
   ---------------------------
  (1) 0001 0100           20   Ignore the(1)

c)   8 bit signed complement:
       1001 0101          -21
     + 0111 1111         +127
     ---------------------------
                          106
```

Since the first number is negative and the second number is positive, I'll subtract the first number (unsigned) from the second.

```
        0111 1111         +127
      - 0001 0101          -21
      -------------------------
        0110 1010          106
```

Since the answer is positive, I'll leave the sign bit as a zero.

```
d)  Problem a) is not valid 276 > 2^8 (256).  Problems b) and c)
    are valid.
```

1.1 A) $16\overline{)757}^{\,47}$ r 5 $\quad .25 \times 16 = 4.00$

$16\overline{)47}^{\,2}$ r 15 = F

$16\overline{)2}^{\,0}$ r 2

$757.25_{10} = 2F5.40_{16}$

= 0010 1111 0101. 0100 0000
 2 F 5 4 0

B) $16\overline{)123}^{\,7}$ r 11 = B_{16} $\quad .17 \times 16 = \underline{2}.72$

$16\overline{)7}^{\,0}$ r 7 = 7 $\quad .72 \times 16 = \underline{11}.52 \quad 11_{10} = B_{16}$

$.52 \times 16 = 8.32$

$123.17_{10} = 7B.2B_{16}$

= 0111 1011 . 0010 1011
 7 B 2 B

1.2 A) 111 010 110 001 . 011
 7 2 6 1 3 → 7261.3_8

$7 \times 8^3 + 2 \times 8^2 + 6 \times 8 + 1 + 3 \times 8^{-1} = 3761.375_{10}$

1110 1011 0001 . 011
 E B 1 . 6 → $EB1.6_{16}$

$14 \times 16^2 + 11 \times 16^1 + 1 + 6 \times 16^{-1} = 3761.375_{10}$

EQUAL

1.3 $3BA.25_{14}$

$3\times14^{2} + 11\times14^{1} + 10 + 2\times14^{-1} + 5\times14^{-2} = 752.1684_{10}$

$752 \div 6 = 125$ r 2
$125 \div 6 = 20$ r 5
$20 \div 6 = 3$ r 2
$3 \div 6 = 0$ r 3

$.1684\times6 = 1.0104$
$.010\times6 = .06$
$.06\times6 = .36$
$.36\times6 = 2.16$

$3BA.25_{14} = 3252.1002_6$

1.5

A)

```
  1111        1111         1111
+ 1010      - 1010       x 1010
 -----       -----       ------
 11001        0101         0000
                          11110
                         000000
                        1111000
                       --------
                       10010110
```

B)

```
  110110      110110        110110
+ 011101    - 011101      x 011101
 -------     -------      --------
 1010011      011001        110110
                           0000000
                         (0110110) Sum
                          11011000
                        (100001110) Sum
                         110110000
                       (1010111110) Sum
                        1101100000
                      -------------
                       11000011110  -> Final Ans
```

c)

```
  100100
+ 010110
  ------
  111010
```

```
  100100
- 010110
```

2's comp

```
  101001
+      1
  ------
  101010
```

NOW ADD

```
  100100
  101010
  ------
 1[001110]
```

```
        100100
       x010110
       -------
       0000000
      1001000
     ---------
     (1001000) Sum
     10010000
     ---------
    (11011000) Sum
    000000000 00
    ------------
   (011011000) Sum
   10010000000
   -----------
   1100011000  -> Final Ans
```

1.6

A)

```
  11110100
  01000111
  --------
  10101101
```

B)

```
  110110
 -011101
  ------
  011001
```

1.7

A) 21+11

```
   010101
 + 001011
   ------
   100000 -> OVERFLOW
```

B) (-14)+(-32)

```
   110010
   100000
   ------
(1)010010 -> OVERFLOW
```

C) (-25)+18

```
   100111
 + 010010
   ------
   111001
```

D) (-12)+13

```
   110100
   001101
   ------
(1)000001
```

E) (-11)+(-21)

```
   110101
   101011
   ------
(1)100000
```

$\boxed{1.8}$ FOR A WORD LENGTH OF N, THE RANGE OF 2'S COMPLEMENT NUMBERS THAT CAN BE REPRESENTED IS -2^{N-1} TO $2^{N-1}-1$

SO, FOR A WORD LENGTH OF 8, THE RANGE IS -2^7 TO 2^7-1, OR -128 TO 127. BECAUSE 1'S COMPLEMENT HAS A "NEGATIVE ZERO" (11111111) IN ADDITION TO ZERO (00000000), THE VALUES THAT CAN BE REPRESENTED RANGE FROM $-(2^7-1)$ TO 2^7-1, OR -127 TO 127

$\boxed{1.10}$ C) 301.12_{10}

$16\overline{)301}$ = 18 r 13 = D_{16}

$16\overline{)18}$ = 1 r 2

$16\overline{)1}$ = 0 r 1

$.12 \times 16 = 1.92$

$.92 \times 16 = 14.72 \rightarrow E_{16}$

$.72 \times 16 = 11.52 \rightarrow B_{16}$

$$\underset{1}{0001}\ \underset{2}{0010}\ \underset{D}{1101}\ .\ \underset{1}{0001}\ \underset{E}{1110}\ \underset{B}{1011}_2 \quad (12D.1EB_{16})$$

$\boxed{1.11}$ A) 101111010100.101

$$\underbrace{101}_{5}\underbrace{111}_{7}\underbrace{010}_{2}\underbrace{100}_{4}.\underbrace{101}_{5} = 5724.5_8$$

$5\times8^3 + 7\times8^2 + 2\times8^1 + 4 + 5\times8^{-1} = 3028.625_{10}$

$$\underbrace{1011}_{B}\underbrace{1101}_{D}\underbrace{0100}_{4}.\underbrace{1010}_{A} = BD4.A$$

$11\times16^2 + 13\times16 + 4 + 10\times16^{-1} = 3028.625_{10}$

EQUAL

1.15 A)

Roth 6th: 1.17

```
   111
   1110
+  1001
  11000
```

```
   1111
-  1001
   0110
```

```
      1111
      1001
   --------
      1111
   000  00
   --------
   (01 111) sum
   0000000
   --------
  (0011111) sum
   1111000
   --------
  10000111 → Final Ans
```

1.17 A)

Roth 6th: 1.20

```
         101110 → Quotient
101 ⟌ 11101001
      101
       1001
        101
        1000
         101
         110
         101
          11 → Remainder
```

1.25 A) 222.22_{10}

Roth 6th: 1.32

$16\overline{)222}$ = 13 r14 → E_{16}

$16\overline{)13}$ = 0 r13 → D_{16}

$.22 \times 16 = 3.52$

$.52 \times 16 = 8.32$

$.32 \times 16 = 5.12$

→ $DE.385_{16}$

1000100	1000101	0101110	0110011	0111000
D	E	.	3	8

Homework 3 Solutions

1.27

Roth 6th: 1.34

A)

1's comp

```
  01001        01001
- 11010  →   + 00101
             -------
               01110
```

2's comp

```
01001      00101
11010  →  +    1
          ------
           00110
             ↓
           01001
         + 00110
         -------
           01111
```

B)

1's comp

```
  11010        11010
- 11001  →   + 00110
             -------
              100000
             +     1
             -------
               00001
```

2's comp

```
11010      00110
11001  →  +    1
          ------
           00111
             ↓
           11010
         + 00111
         -------
         (1)00001
```

C)

1's comp

```
  10110        10110
- 01101  →   + 10010
             -------
              101000
             +     1
             -------
               01001 → OVERFLOW
```

2's comp

```
10110      10010
01101  →  +    1
          ------
           10011
             ↓
           10110
         + 10011
         -------
         (1)01001   OVERFLOW
```