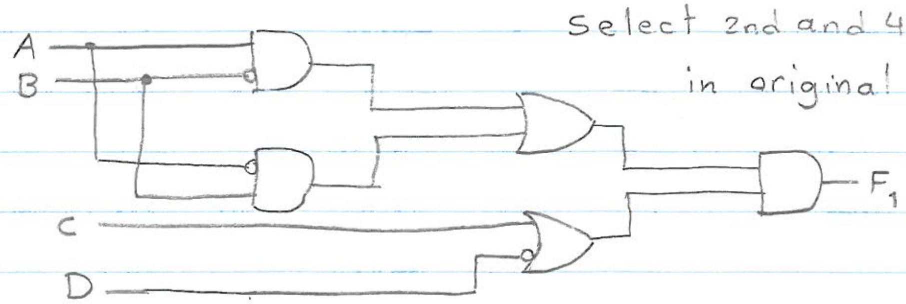
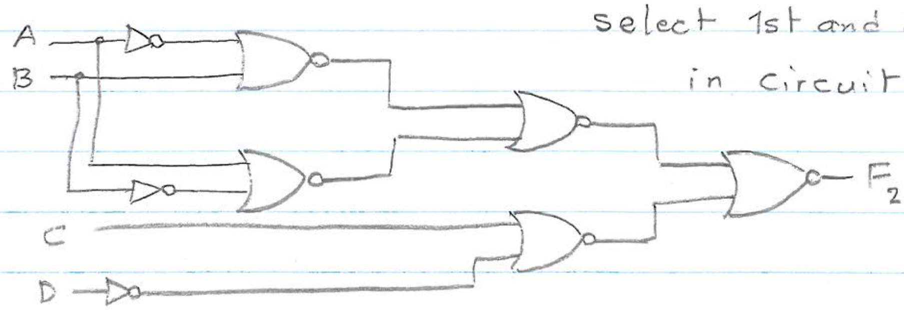
1. AND-OR

select 2nd and 4th layer in original circuit



NOR

select 1st and 3rd layer in circuit above



check

$$F_1 = (A\bar{B} + B\bar{A})(C + \bar{D})$$

$$= \overline{\overline{(A\bar{B} + \bar{A}B)} + \overline{(C+\bar{D})}}$$

$$= \overline{\overline{\left[\overline{(\bar{A}+B)} + \overline{(\bar{B}+A)}\right]} + (C+\bar{D})} = F_2$$

2. (a) $(110101.101)_2 = 2^5 + 2^4 + 2^2 + 2^0 + 2^{-1} + 2^{-3}$

$= 32 + 16 + 4 + 2 + \frac{1}{2} + \frac{1}{8}$

$= 54.625$

(b) $(1101110.1101)_2 = (001\ 101\ 110.110\ 100)_2 = (156.64)_8$

(c) 〃 $= (0110\ 1110.1101)_2 = (6E.D)_{16}$

(d) $(785.96)_{10} = (1100010001.111)_2$

3. (a) A + B

```
   1    1
   01100101
 + 11010110
 ----------
 1 00111011      no overflow
```

(b) B − A = B + (−A)

```
   1111
   11010110
 + 10011011   ← A's 2's complement = −A
 ----------
 1 01110001
```

sign of result ≠ sign of operands

∴ overflow (i.e. 8-bit answer isn't valid)

(c) A × 101 = 1101000l

since 101 is negative, we take its 2's complement, which is 011.

```
   101
 ×  −3
 -----
  −303
```

Decimal version

```
    01100101
 ×        11
 -----------
    01100101
   01100101
 -----------
   100101111   --2's comp.-->   1101000l
```

since we know the result of multiplication is negative, we take 2's complement of the product

Note: when muliplying two binary numbers of m and n bits, m+n bits are needed to accommodate the result.

(d) A + 0111101 ← 7-bits

= A + 00111101 ← sign extended to 8-bits

= 10100010 with overflow (for 8-bit answer)

```
   111  1  1
   01100101
 + 00111101
 ----------
   10100010
```

overflow

4. $F = a\bar{b} + d\bar{c}b + dc + \bar{a}cd + a\bar{b}\bar{c}d$

$= a\bar{b} + dc + bd$

ab \ cd	00	01	11	10
00			1	
01		1	1	
11		1	1	
10	1	1	1	1

check by Algebra

$F = a\bar{b} + b\bar{c}d + cd + \bar{a}cd + a\bar{b}\bar{c}d$

$= a\bar{b}(1 + \bar{c}d) + cd(1 + \bar{a}) + b\bar{c}d$

$= a\bar{b} + cd + b\bar{c}d$

$= a\bar{b} + d(c + b\bar{c})$

$= a\bar{b} + d(c+b)(c+\bar{c}) = a\bar{b} + cd + bd$ ✓

5.

$F = c\bar{d} + \bar{b}\bar{d} + a\bar{d}$.

ab \ cd	00	01	11	10
00	1		d	d
01		d		1
11	1			d
10	d	d	d	1