

DSDL Midterm

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1. (5%) Please calculate following translate

(a) $(11010.11)_2 = (\quad)_{10}$

(b) $(41)_{10} = (\quad)_2$

$$(a) \quad (11010.11)_2 = (2^4 + 2^3 + 2^1 + 2^{-1} + 2^{-2})_{10} = (16 + 8 + 2 + 0.5 + 0.25)_{10} = (26.75)_{10}$$

$$(b) \quad (41)_{10} = (32 + 8 + 1)_{10} = (2^5 + 2^3 + 2^0)_{10} = (101001)_2$$

2. (10%) Prove the identity of each of the following Boolean equations, using algebraic manipulation.

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

(b) $AB+AC+BC = \overline{(A+B)(A+C)(B+C)}$

$$\begin{aligned} \text{(a)} \quad & (A+B)(\bar{A}+C)(B+C) \\ &= (A\bar{A} + AC + \bar{A}B + BC)(B+C) \\ &= ABC + \bar{A}B + BC + AC + \bar{A}BC \\ &= BC + \bar{A}B + AC \\ &= BC + \bar{A}B + AC + A\bar{A} \\ &= (A+B)(\bar{A}+C) \end{aligned}$$

$$\begin{aligned} \text{(b)} \quad & \overline{(A+B)(A+C)(B+C)} \\ &= \overline{A+B} + \overline{A+C} + \overline{B+C} \\ &= \bar{A} \cdot \bar{B} + \bar{A} \cdot \bar{C} + \bar{B} \cdot \bar{C} \end{aligned}$$

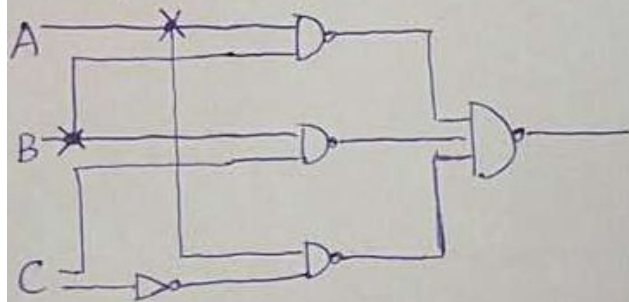
3. (20%) Please draw the logic circle design of following Boolean functions.

(a) $F = AB + BC + \overline{AC}$ (logic circle design only use NAND and NOT gates)

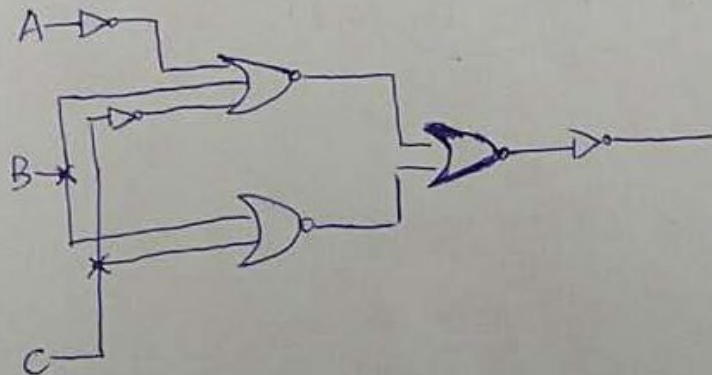
(b) $F = A\overline{B}C + \overline{B}C$ (logic circle design only use NOR and NOT gates)

3. (a) $F = \overline{AB} + \overline{BC} + \overline{AC}$
 $= \overline{AB \cdot BC \cdot AC}$

$$F = AB + BC + AC = BC + AC$$



$$\begin{aligned} \text{b) } F &= \overline{A}BC + \overline{B}C = \overline{A}BC + \overline{B}C \\ &= \overline{A+B+C} + \overline{B+C} \quad \text{也可化简} \\ &= \overline{\overline{A+B+C}} + \overline{\overline{B+C}} \quad F = \overline{A}BC + \overline{B}C \\ &= \overline{A+B+C} + \overline{B+C} = \overline{A}B + \overline{B}C \end{aligned}$$



4. (15%) Use the K-map method to find the minimized sum-of-product expressions:

(a) $F = \overline{B}C + \overline{B}\overline{D} + \overline{A}CD + ABC\overline{C} + \overline{A}\overline{B}\overline{C}D$

(b) $F(A,B,C,D) = \sum m(1,7,9,10,11,12,13,15)$

(c) $F(A,B,C,D) = \sum m(5,6,9,10) + \sum d(0,1,2,13,14,15)$

4. (a) $F = \overline{B}C + \overline{B}\overline{D} + \overline{A}CD + ABC\overline{C} + \overline{A}\overline{B}\overline{C}D$

AB \ CD	00	01	11	10
00	1		1	1
01	1		1	1
11				1
10				1

$$F = \overline{B} + \overline{A}\overline{C}$$

4. (15%) Use the K-map method to find the minimized sum-of-product expressions:

(a) $F = \overline{B}C + \overline{B}\overline{D} + \overline{A}CD + ABC\overline{C} + \overline{A}\overline{B}CD$

(b) $F(A,B,C,D) = \sum m(1,7,9,10,11,12,13,15)$

(c) $F(A,B,C,D) = \sum m(5,6,9,10) + \sum d(0,1,2,13,14,15)$

(b) $F(A,B,C,D) = \sum m(1,7,9,10,11,12,13,15)$

AB \ CD	00	01	11	10
00			1	
01	1	1	1	1
11		1	1	1
10			1	1

$F = AD + ABC\overline{C} + \overline{B}\overline{C}D + \overline{A}\overline{B}C + BCD$

This is wrong

← This circle is not necessary.

$\Rightarrow F = ABC\overline{C} + \overline{B}\overline{C}D + \overline{A}\overline{B}C + BCD$

4. (15%) Use the K-map method to find the minimized sum-of-product expressions:

(a) $F = \overline{B}C + \overline{B}\overline{D} + \overline{A}\overline{C}D + ABC\overline{C} + \overline{A}\overline{B}\overline{C}D$

(b) $F(A,B,C,D) = \sum m(1,7,9,10,11,12,13,15)$

(c) $F(A,B,C,D) = \sum m(5,6,9,10) + \sum d(0,1,2,13,14,15)$

(c) $F(A,B,C,D) = \sum m(5,6,9,10) + \sum d(0,1,2,13,14,15)$

AB \ CD	00	01	11	10
00	d			
01	d	1	d	1
11			d	
10	d	1	d	1

$$F = \overline{C}D + C\overline{D}$$

$$= C \oplus D$$

5. (15%) Implement the following functions using decoders and any size OR gates you may need:

(a) $F(P,Q,R) = (PQ+R)'$ using a 3:8 decoder

(b) $F(P,Q,R,S,T) = P'Q'R'(S+T)$ using a 2:4 decoder

$$5. (a) F(P, Q, R) = (PQ + R)'$$

$$= (PQ)' \cdot R'$$

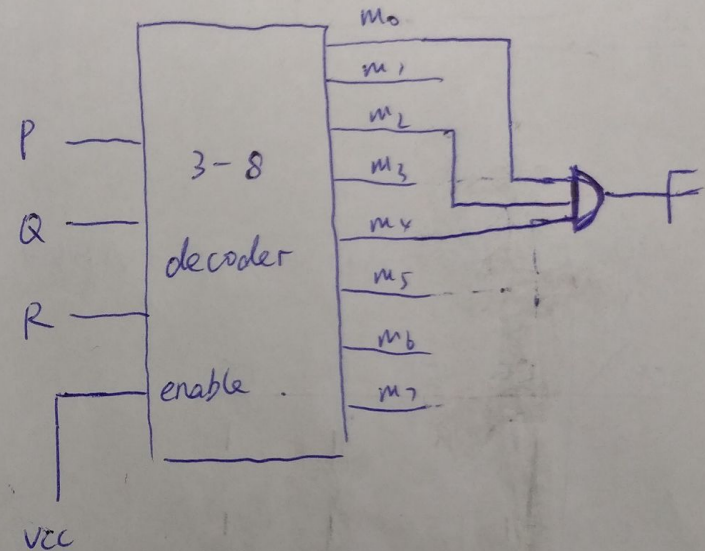
$$= (P' + Q') \cdot R'$$

$$= P'R' + Q'R'$$

$$= P'QR' + P'Q'R' + PQ'R' + P'Q'R'$$

$$= P'Q'R' + PQ'R' + P'Q'R'$$

$$= \sum m(0, 2, 4)$$

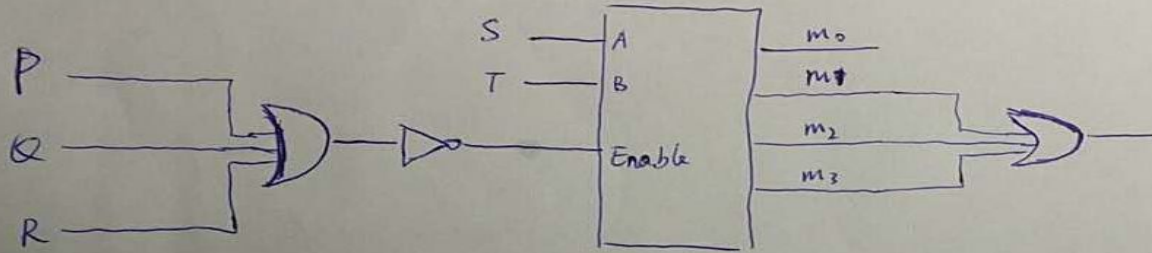


5. (15%) Implement the following functions using decoders and any size OR gates you may need:

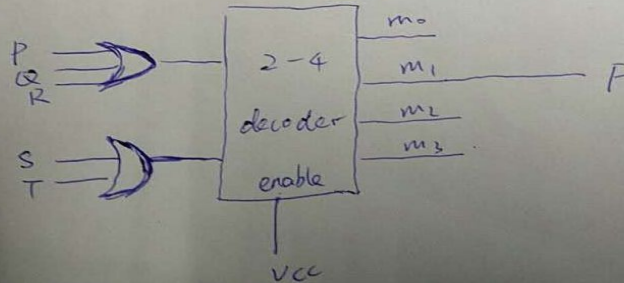
(a) $F(P,Q,R) = (PQ+R)'$ using a 3:8 decoder

(b) $F(P,Q,R,S,T) = P'Q'R'(S+T)$ using a 2:4 decoder

5. (b) $F(P, Q, R, S, T) = P'Q'R'(S+T)$



(b) $F(P, Q, R, S, T) = P'Q'R'(S+T) = (P+Q+R)'(S+T)$

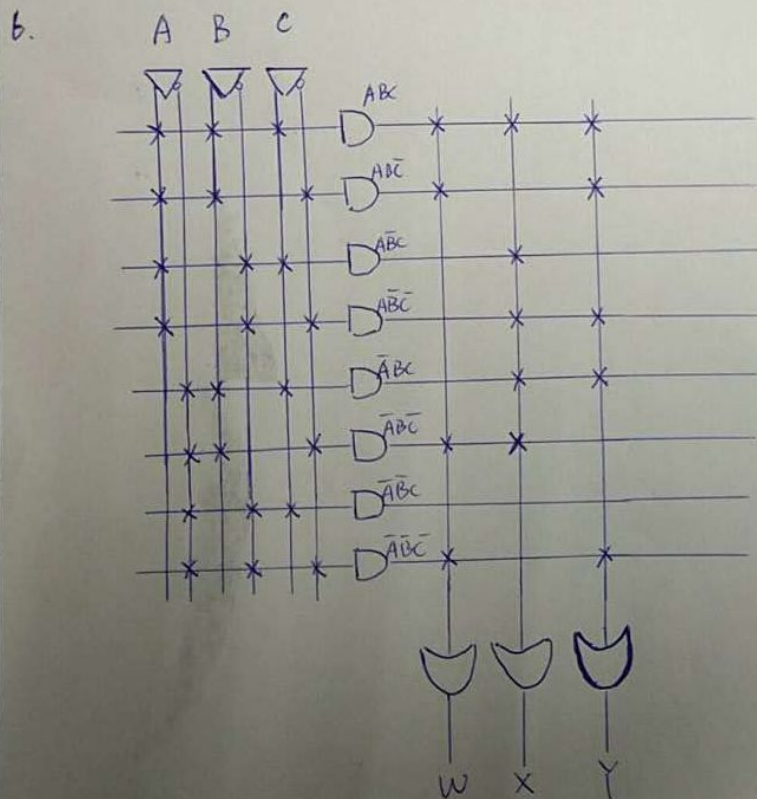


6. (15%) Map the following functions to the PLA below:

$$W = AB + A'C' + BC'$$

$$X = ABC + AB' + A'B$$

$$Y = ABC' + BC + B'C'$$



$$W = AB + A'C' + BC'$$

$$X = ABC + AB' + A'B$$

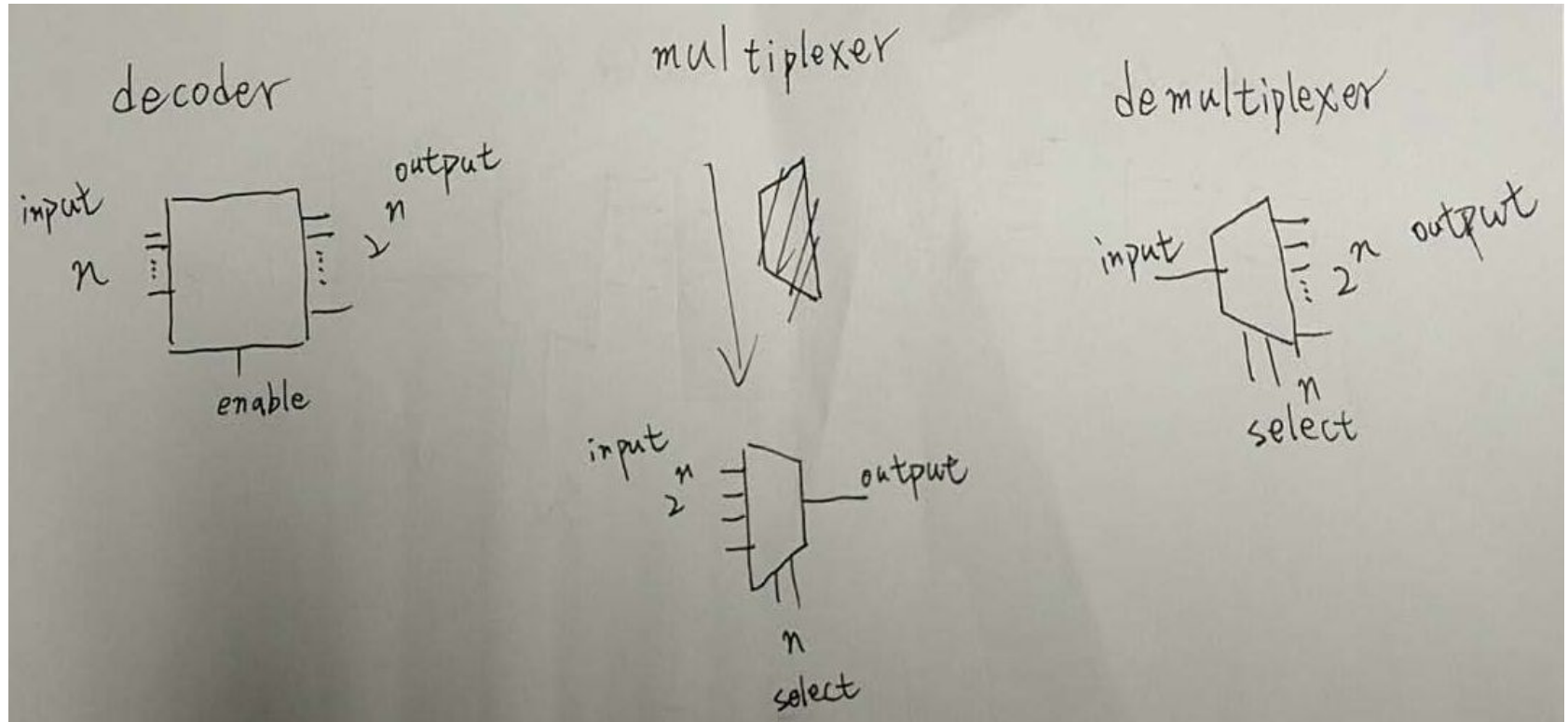
$$Y = ABC' + BC + B'C'$$

~~$$W = AB + A'C' + BC' = AB + A'C'$$~~

~~$$= ABC + ABC + \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C}$$~~

~~X =~~

7. (10%) Define and differentiate the following terms: decoder, demultiplexer, and multiplexer. Mention the number of inputs, outputs, enable, and select bits, if any.



8. (10%) (Verilog HDL) Take a look at the following Verilog program.
- a. (3%) Can a Verilog module name start with a number?
 - b. (4%) Do “clk” below need to be declared in the parameter list?
 - c. (3%) Should the module end with “endmodule” or “endmodules”?

```
module 16x16-MAC (out, rst, op1, op2)
input clk, rst;
input [15:0] op1, op2;
output [39:0] out;
reg [31:0] product;
assign product = op1 * op2;
//40-bit accumulator after 16x16 multiplier
always @(posedge clk || negedge rst)
    if(rst) out = 0;
    else out = out + product;
endmodules
```