Logic design (Fall 2021)

Quiz # 9

Name:_____ID:_____

1. (40%) Realize the function

$F(A,B,C,D) = BCD + AB'C' + AB'CD' + ABC'D + AB'C'D'$

$F(A,B,C,D) = BCD + AB'C'D + AB'C'D' + AB'D' + ABC'D$

using only AND gates and NOT(INV) gates and a 4-to-1 multiplexer with A and B as the select inputs where A is the most significant bit and B is the least significant bit. Note that complement inputs are not allowed.

(a) (28%) What is the logic expression in each mux inputs?
(using A/B/C/D/A'/B'/C'/D'/0/1 to represent the *logic expression (a) ~ logic expression (d)*)

(b) (12%) You should use the minimum total number of AND gates and NOT gates. How many AND gate and NOT gate you need to use respectively?
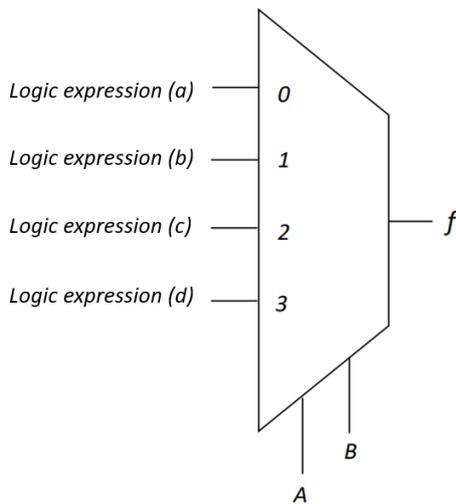
Ans:

(a) Logic expression (a): 0

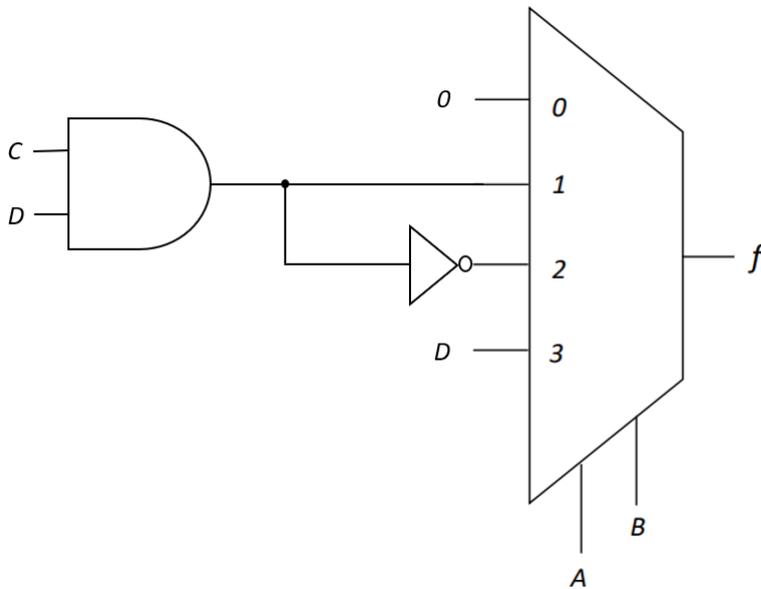Logic expression (b): CD

Logic expression (c): C'+D'

Logic expression (d): D

(each term would deduct 7 points)

P.s. please simplify the logic expression next time!

(b) 1 AND gate and 1 NOT gate

(each answer would deduct 6 points)

2. (60%) Implement the following equations using the PLA with four product terms only.

F1(A,B,C,D) = $\prod$ M(1, 3, 5, 6, 7, 8, 9, 11, 12, 14)

F2(A,B,C,D) = $\prod$ M(0, 3, 4, 6, 7, 8, 11, 12, 14)

F1(A,B,C,D) = $\sum$ m(0, 2, 4, 10, 13, 15)

F2(A,B,C,D) = $\sum$ m (1, 2, 5, 9, 10, 13, 15)

(a) (40%) List the four product terms used in the PLA

(b) (20%) Following shows the PLA structure, of which left and right side are AND array and OR array respectively. The intersection of a row and input or output lines indicates the presence of a switching element in the array. Indicate the connections which will be made to program the PLA If Line 1 intersects A' and Line 1 intersects F1, use **1A' 1F1** to represent it.
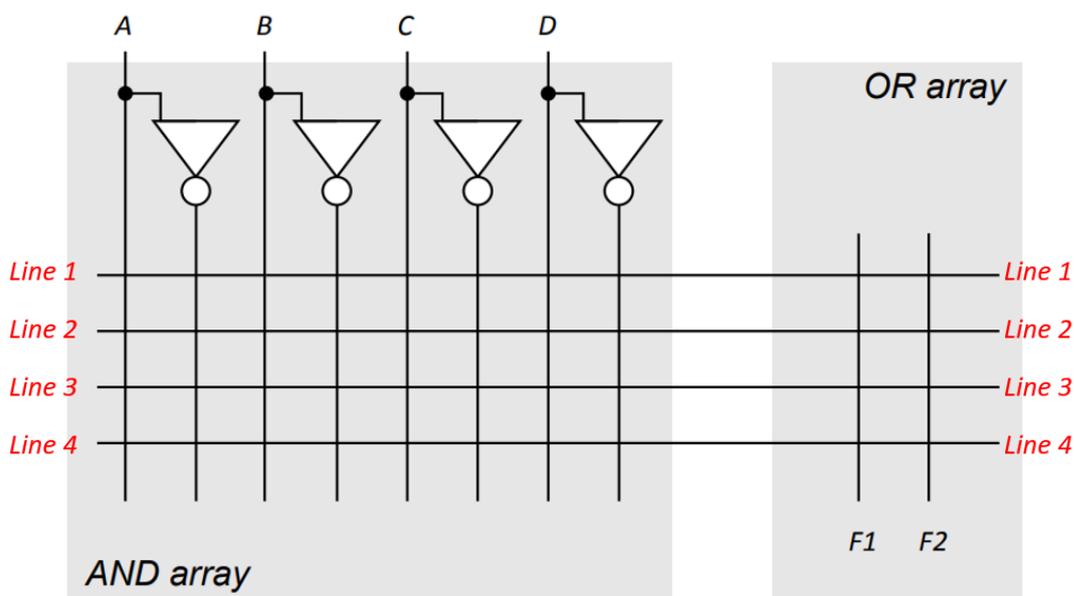
Ans:

F1 = A'C'D' + B'CD' + ABD

F2 = C'D + B'CD' + ABD

➜ A'C'D' + B'CD' + ABD + C'D (each term deducts 10 points)

Map for F1 (AB columns: 00, 01, 11, 10; CD rows: 00, 01, 11, 10)

CD \ AB	00	01	11	10
00	1 (0)	1 (4)	0 (12)	0 (8)
01	0 (1)	0 (5)	1 (13)	0 (9)
11	0 (3)	0 (7)	1 (15)	0 (11)
10	1 (2)	0 (6)	0 (14)	1 (10)

Map for F2 (AB columns: 00, 01, 11, 10; CD rows: 00, 01, 11, 10)

CD \ AB	00	01	11	10
00	0 (0)	0 (4)	0 (12)	0 (8)
01	1 (1)	1 (5)	1 (13)	1 (9)
11	0 (3)	0 (7)	1 (15)	0 (11)
10	1 (2)	0 (6)	0 (14)	1 (10)

1A' 1C' 1D' 1F1

2B' 2C 2D' 2F1 2F2

3A 3B 3D 3F1 3F2

4C' 4D 4F2

(each line deducts 5 points)