EE 2000 Logic Circuit
Design Semester A 2021/22

Tutorial 3

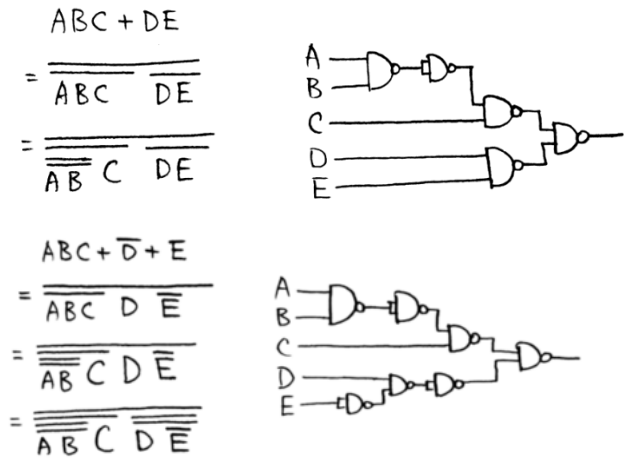
1. Use a truth table to present (A + B + C +D)’ = A’ B’ C’ D’

Ans:

A	B	C	D	A’	B’	C’	D’	A’B’C’D’	(ABCD)’
0	0	0	0	1	1	1	1	1	1
0	0	0	1	1	1	1	0	0	0
0	0	1	0	1	1	0	1	0	0
0	0	1	1	1	1	0	0	0	0
0	1	0	0	1	0	1	1	0	0
0	1	0	1	1	0	1	0	0	0
0	1	1	0	1	0	0	1	0	0
0	1	1	1	1	0	0	0	0	0
1	0	0	0	0	1	1	1	0	0
1	0	0	1	0	1	1	0	0	0
1	0	1	0	0	1	0	1	0	0
1	0	1	1	0	1	0	0	0	0
1	1	0	0	0	0	1	1	0	0
1	1	0	1	0	0	1	0	0	0
1	1	1	0	0	0	0	1	0	0
1	1	1	1	0	0	0	0	0	0

2. Implement the following expression with **2-input NAND gates** only:
   (a) *ABC* + *DE*
   (b) *ABC* + *D’* + *E*

Ans:



3. Given a truth table:

a	*b*	*c*	*d*	*f*
0	0	0	0	0
0	0	0	1	0
0	0	1	0	X
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	X
0	1	1	1	X
1	0	0	0	0
1	0	0	1	X
1	0	1	0	1
1	0	1	1	0
1	1	0	0	X
1	1	0	1	0
1	1	1	0	X
1	1	1	1	0

(a) Express *f* as product of maxterms function in numeric form.

(b) Find its MPS form using K-map.

(c) From the answer of (b), please design a logic circuit by NAND gates only.

Ans:

(a) $f(a, b, c, d) = \Pi M(0, 1, 3, 5, 8, 11, 13, 15) \cdot \Pi D(2, 6, 7, 9, 12, 14)$

(b)

cd \ *ab*	00	01	11	10
00	0		X	0
01	0	0	0	X
11	0	X	0	0
10	X	X	X	

$$\overline{f(a,b,c,d)} = d + \overline{bc}$$

$$f(a,b,c,d) = \overline{d + \overline{bc}}$$

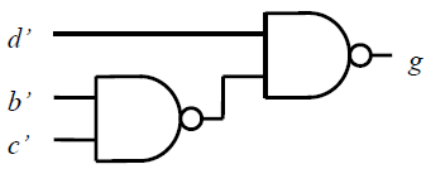
$$= (\overline{d}) \cdot (b + c)$$

(c)

$$g = \overline{f(a,b,c,d)} = d + \overline{b} \cdot \overline{c}$$

$$= \overline{\overline{d + \overline{b} \cdot \overline{c}}}$$

$$= \overline{(\overline{d}) \cdot (\overline{\overline{b} \cdot \overline{c}})}$$



4. Design a combinational circuit for a 3-bit Binary-to-Gray code converter.

Ans:

Truth table

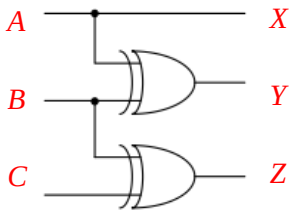
Input			Output		
A	*B*	*C*	*X*	*Y*	*Z*
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	1
0	1	1	0	1	0
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	1	0	1
1	1	1	1	0	0

$X = A$ (by visual inspection of the truth table)

$Y = A'BC' + A'BC + AB'C' + AB'C$
$= A'B(C' + C) + AB'(C' + C)$
$= A'B + AB'$
$= A \oplus B$

$Z = A'B'C + A'BC' + AB'C + ABC'$
$= B'C(A' + A) + BC'(A' + A)$
$= B'C + BC'$
$= B \oplus C$

Circuit:



5. Joe, Jack, and Jim get together once a week to either go to a movie or go bowling. To decide what to do, they vote and a simple majority wins. Assuming a vote for the movie is represent as a 1, design a NAND gate circuit that automatically computes the decision.

Ans:

Joe / x	Jack / y	Jim / z	Decision / *f*
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$f(x, y, z) = \Sigma\, m\,(3, 5, 6, 7)$ …. By K-map $f =$ xy + xz + yz (Please draw the circuit by own)