Ninevah University
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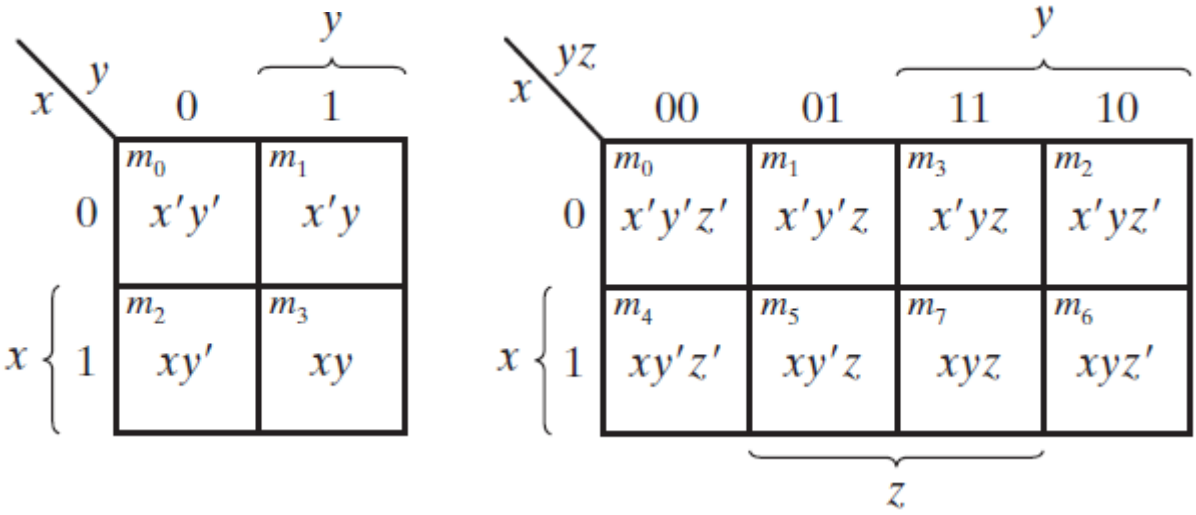
Systems & Control Engineering

Karnaugh Map (K Map)

The Karnaugh map provides a graphical method for simplification and manipulation of a Boolean expression.

The map is a diagram consisting of squares. Each square or cell represents one of the minterms.

$$No.of\ Minterms = No.of\ Squares = 2^{no.\ of\ Variables}$$



Solution Procedure

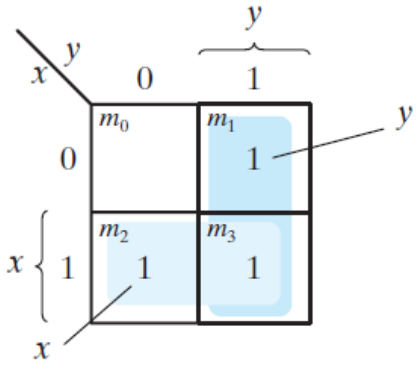
1. Draw the frame of the K-Map.
2. Complete the Truth Table of the function that need to be simplified.
3. Place the value of each minterm (0 or 1) into the corresponding cell.
4. Group the adjacent (المتجاورة) Minterms together. Try to make the group as big as possible.
5. Each group must **only** contain 1 or 2 or 4 or 8 Minterms.
6. The Boolean expression of each group is obtained by taking the variables that doesn't changes in value as we move from one adjacent column to the next.
7. The Boolean function is obtained by adding of the Boolean expression of all the groups Highlighted.

Two-Variable K-Map

In two-variable map, there are four minterms and hence the map consists of four squares.

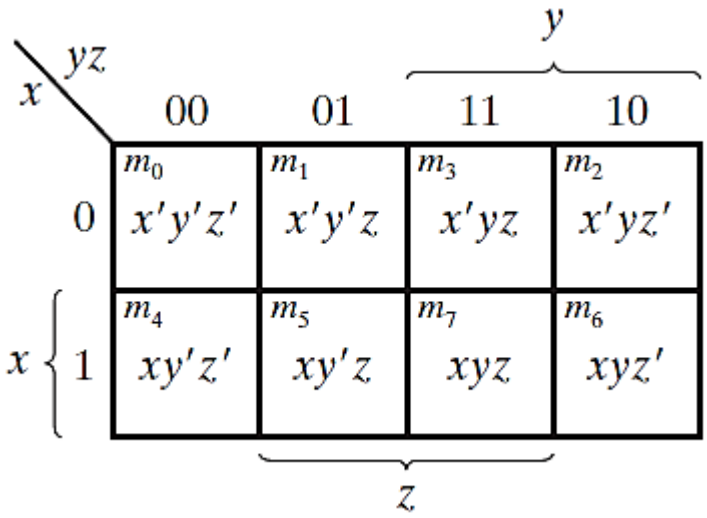
Ex) Use K-Map to simplify the function $F = x'y + xy' + xy$

x	y	F
0	0	0
0	1	1
1	0	1
1	1	1



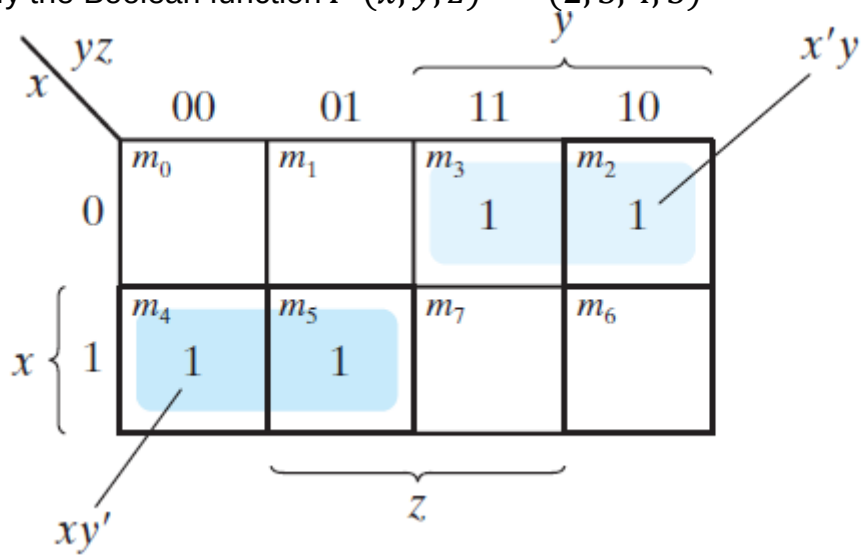
Three-Variable K-Map

There are eight minterms for three binary variables. Therefore, the map consists of eight squares.



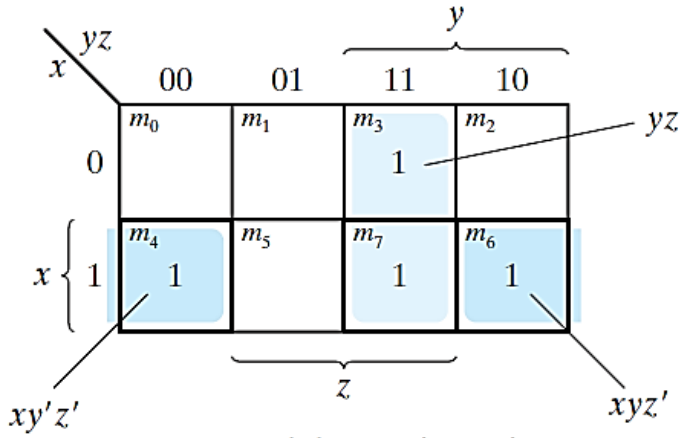
Note that the minterms are arranged, not in a binary sequence, but in a sequence similar to the Gray code. That is only **one bit changes in value** from one adjacent column to the next.

Ex) Simplify the Boolean function $F\ (x, y, z)\ =\ (2, 3, 4, 5)$



$\boldsymbol{F\ (x, y, z)\ =(2, 3, 4, 5)\ =\ x'y\ +\ xy'}$

Ex) Simplify the Boolean Function *F (x, y, z) = (3, 4, 6, 7)*



$F = yz + xz'$

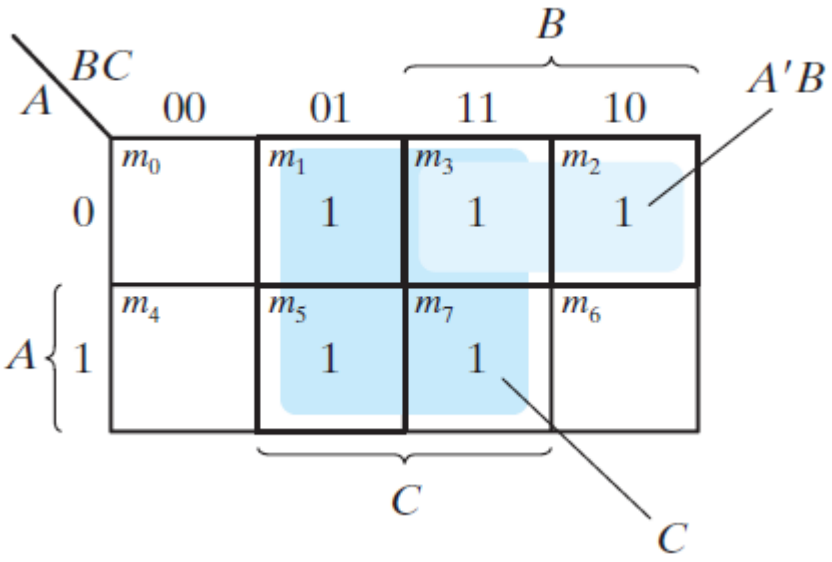
Note: $xy'z' + xyz' = xz'$

Ex) Simplify the Boolean function $F = A'C + A'B + AB'C + BC$

Truth Table

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

The K-Map is as follow



The Boolean function is $F = C + A'B$