Introduction of K-Map (Karnaugh Map)

In numerous digital circuits and other practical problems, finding expressions that have minimum variables becomes a prerequisite. In such cases, minimisation of Boolean expressions is possible that have 3 or 4 variables. It can be done using the Karnaugh map without using any theorems of Boolean algebra. The K-map can easily take two forms, namely, Sum of Product or SOP and Product of Sum or POS, according to what we need in the problem. K-map is a representation that is table-like, but it gives more data than the TRUTH TABLE. Fill a grid of K-map with 1s and 0s, then solve it by creating various groups.

Solving an Expression Using K-Map

Here are the steps that are used to solve an expression using the K-map method:

1. Select a K-map according to the total number of variables.

2. Identify maxterms or minterms as given in the problem.

3. For SOP, put the 1s in the blocks of the K-map with respect to the minterms (elsewhere, 0s).

4. For POS, putting 0's in the blocks of the K-map with respect to the maxterms (elsewhere 1's).

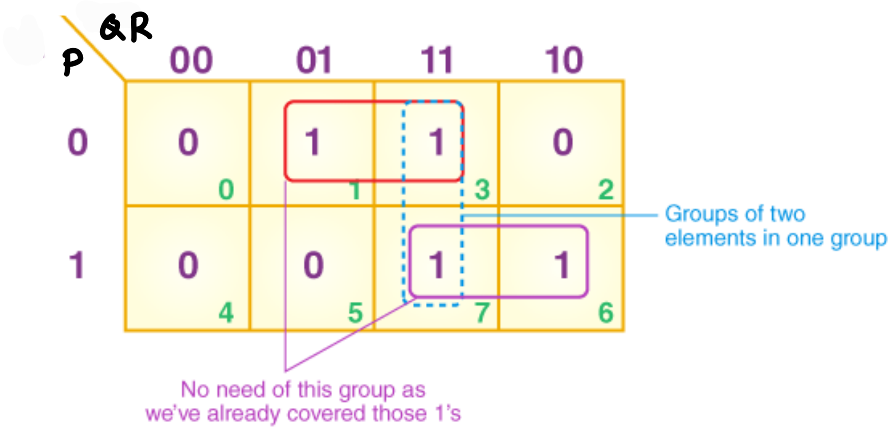
5. Making rectangular groups that contain the total terms in the power of two, such as 2,4,8 ..(except 1), and trying to cover as many numbers of elements as we can in a single group.

6. From the groups that have been created in step 5, find the product terms and then sum them up for the SOP form.

SOP FORM:

1. 3 variables K-map:

Z = ∑P, Q, R (1, 3, 6, 7)



From the red group, the product term would be –

P’R

From the purple group, the product term would be –

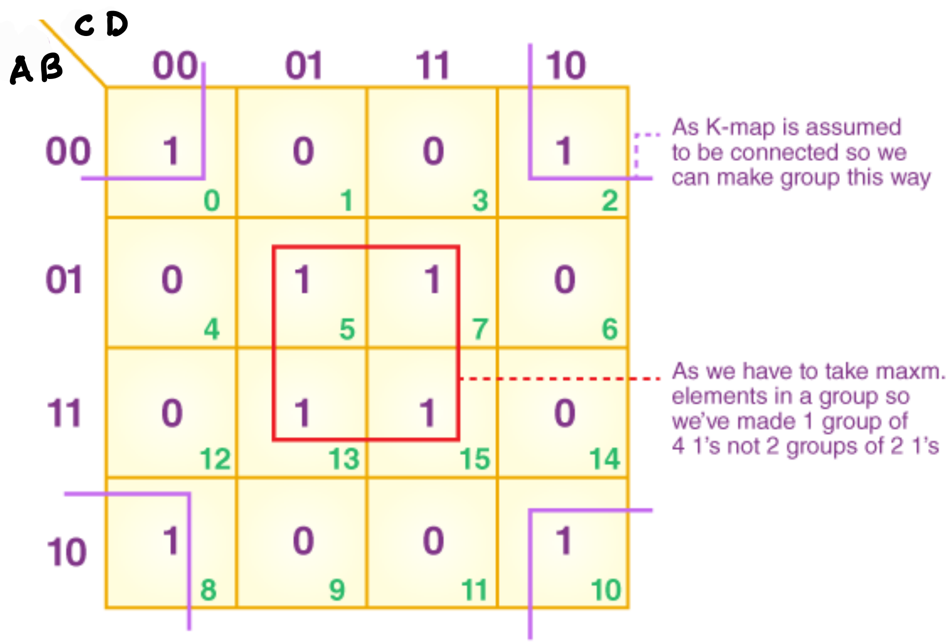
PQ

If we sum these product terms, then we will get this final expression

(P’R + PQ)

2. 4 variables K-map:

F (A, B, C, D) = ∑(0, 2, 5, 7, 8, 10, 13, 15)



From the red group, the product term would be –

BD

From the purple group, the product term would be –

B’D’

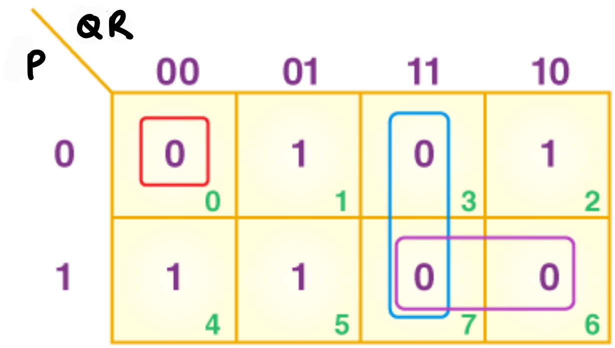
If we sum these product terms, then we will get this final expression

(BD + B’D’)

POS FORM:

1. 3 variables K-map

F (P, Q, R) = π(0,3,6,7)



From the purple group, the terms would be

P Q

If we take the complement of these two

P’ Q’

And then sum up them

(P’ + Q’)

From the blue group, the terms would be

Q R

When we take the complement of these terms

Q’ R’

And then sum them up

(Q’ + R’)

From the red group, the terms would be

P’ Q’ R’

If we take the complement of the two terms

P Q R

And then sum them up

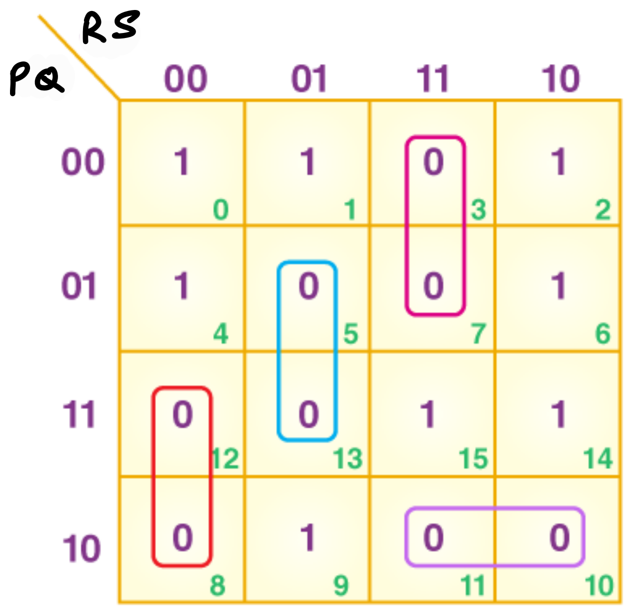
(P + Q + R)

If we take the product of these three terms, then we will get this final expression –

(P’ + Q’) (Q’ + R’) (P + Q + R)

2. 4 variables K-map

F (P, Q, R, S) = π (3, 5, 7, 8, 10, 11, 12, 13)



From the blue group, the terms would be

R’ S Q

We take their complement and then sum them

(R + S’+ Q’)

From the maroon group, the terms would be

R S P’

We take their complement and then sum them

(R’ + S’+ P)

From the red group, the terms would be

P R’ S’

We take their complement and then sum them

(P’ + R + S)

From the purple group, the terms would be

P Q’ R

We take their complement and then sum them

(P’ + Q + R’)

Finally, we will express these in the form of the product –

(R + S’+ Q’).(R’ + S’+ P).(P’+ R + S).(P’+ Q + R’)

Note – Always remember that POS ≠ (SOP)’

Here, the correct form would be (POS of F) = (SOP of F’)’