* Optimize the following Boolean functions by means of a four-variable map.

1. $\mathrm{F(A,B,C,D)} = \sum m\ (0,1,3,5,6,9,10,12,15)$

2. $\mathrm{F(A,B,C,D)} = \sum m\ (0,1,3,8,9,11,12,13,14,15)$

3. $\mathrm{F(A,B,C,D)} = \sum m\ (0,1,2,8,9,10,11,12,13,14,15)$

* Find the minterms of the following expressions by first plotting each expression on a map.

4. $\mathrm{X}\overline{Y} + X\overline{Z} + XYZ$

5. $\mathrm{XY}\overline{Z} + W\overline{X}Y + WX\overline{Y} + \overline{W}\,\overline{X}Z + WXYZ$

* Optimize the following Boolean functions by finding all prime implicants and essential prime implicants and applying the selection rule.

6. $\mathrm{F(W,X,Y,Z)} = \sum m\ (0,1,3,4,6,8,10,11,12,13)$

7. $\mathrm{F(A,B,C,D)} = \sum m\ (0,2,5,7,10,11,13,14,15)$

8. $\mathrm{F(W,X,Y,Z)} = \sum m\ (1,3,4,5,7,9,11,14,15)$

* Optimize the following Boolean functions F together with the don't-care conditions d. Find all prime implicants and essential prime implicants, and apply the selection rule.

9. $\mathrm{F(A,B,C)} = \sum m\,(3,5,6),\ \ \mathrm{d(A,B,C)} = \sum m\,(0,7)$

10. $\mathrm{F(W,X,Y,Z)} = \sum m\,(0,2,4,5,8,14,15),\ \ \mathrm{d(W,X,Y,Z)} = \sum m\,(7,10,13)$

11. $\mathrm{F(A,B,C,D)} = \sum m\,(4,6,7,8,12,15),$

    $\mathrm{d(A,B,C,D)} = \sum m\,(2,3,5,10,11,14)$