1. Optimize each of the following Boolean functions as a SOP using a K-map of the appropriate size:

   a. $F(X,Y,Z) = \Sigma_m(0,2,5,6,7)$

   b. $F(W,X,Y,Z) = \Pi M(1,3,5,7,12,13,14,15)$

   c. $F(A,B,C,D) = (\bar{A}+\bar{B}+D)(\bar{A}+\bar{D})(A+B+\bar{D})(A+\bar{B}+C+D)$ Start by obtaining $\bar{F}$ as a SOP

   d. $F(A,B,C,D) = A\bar{C} + \bar{B}D + \bar{A}CD + ABCD$

2. For each of the following Boolean functions, list all possible prime implicants (PIs) and mark on the list all those PIs that are essential prime implicants. Give an optimized SOP expression for each function.

   a. $F(W,X,Y,Z) = \Sigma_m(0,1,2,5,6,8,9,10,12,14,15)$

   b. $F(W,X,Y,Z) = \Pi M(1,4,6,9,12,13)$

3. Optimize each of the functions as:
   - A sum of products (SOP)   - A product of sums (POS)

   a. $F(A,B,C,D) = \Pi M(0,1,3,5,7,9,10,13,15)$

   b. $F(x,y,z) = xz' + y'z' + yz' + xy'$

   (for part b use Boolean algebra to prove the equivalence of the minimized SOP & POS forms obtained)

4. - Optimize the following function by best utilizing the don't care conditions d

   a. $F(W,X,Y,Z) = \Sigma_m(2,4,7,10,12,14)$, $d(W,X,Y,Z) = \Sigma_m(0,3,6,8,13)$

      - For your optimized circuit: with WXYZ = 1101, F = ___ (1/0), with WXYZ = 1000, F = ___ (1/0).

   b. $F(X,Y,Z) = \Sigma(0,1,2,4)$, $d(X,Y,Z) = Y(Z+X)$

5. Use a 4-variable (A,B,C,D) K-map to simplify the following Boolean function to 2 literals
   Hint: Utilize the fact that F is given as a product of maxterms.

   $F(A,B,C,D) = (A+\bar{B}+C+\bar{D})(A+\bar{B}+\bar{C}+\bar{D})(\bar{A}+\bar{B}+C+\bar{D})(\bar{A}+\bar{B}+\bar{C}+\bar{D})$

6. Verify that $\overline{W}X(\bar{Z}+\overline{YZ}) + X(W+\overline{WYZ})$ can be simplified to 1 literal:
   i. Using Boolean algebra
   ii. Using a K-map of the appropriate size.