Mechatronics
Department
CSE115

Faculty of Engineering
Ain Shams University

# Digital Design

## Sheet 4

1) Using Karnaugh maps, find a minimal sum-of-products expression for each of the following logic functions. Indicate the distinguished 1-cells in each map.

   a) $F = \Sigma_{X,Y,Z}(1,3,5,6,7)$
   b) $F = \Sigma_{W,X,Y,Z}(1,4,5,6,7,9,14,15)$
   c) $F = \prod_{W,X,Y}(0,1,3,4,5)$
   d) $F = \Sigma_{W,X,Y,Z}(0,2,5,7,8,10,13,15)$
   e) $F = \prod_{A,B,C,D}(1,7,9,13,15)$
   f) $F = \Sigma_{A,B,C,D}(1,4,5,7,12,14,15)$

2) Find a minimal product-of-sums expression for each function in **Problem (1)** using the method of Section 4.3.6.

3) Using Karnaugh maps, find a minimal sum-of-products expression for each of the following logic functions. Indicate the distinguished 1-cells in each map

   a) $F = \Sigma_{A,B,C}(0,1,2,4)$
   b) $F = \Sigma_{W,X,Y,Z}(1,4,5,6,11,12,13,14)$
   c) $F = \prod_{A,B,C}(1,2,6,7)$
   d) $F = \Sigma_{W,X,Y,Z}(0,1,2,3,7,8,10,11,15)$
   e) $F = \Sigma_{W,X,Y,X}(1,2,4,7,8,11,13,14)$
   f) $F = \prod_{A,B,C,D}(1,3,4,5,6,7,9,12,13,14)$

4) Find a minimal product-of-sums expression for each function in **Problem (3)** using the method of Section 4.3.6.

5) Using Karnaugh maps, find a minimal sum-of-products expression for each of the following logic functions. Indicate the distinguished 1-cells in each map.

   a) $F = \Sigma_{W,X,Y,Z}(0,1,3,5,14) + d(8,15)$
   b) $F = \Sigma_{W,X,Y,Z}(0,1,2,8,11) + d(3,9,15)$
   c) $F = \Sigma_{A,B,C,D}(1,5,9,14,15) + d(11)$
   d) $F = \Sigma_{A,B,C,D}(1,5,6,7,9,13) + d(4,15)$
   e) $F = \Sigma_{W,X,Y,Z}(3,5,6,7,13) + d(1,2,4,12,15)$

6) Repeat **Problem (5)**, finding a minimal product-of-sums expression for each logic function.

7) Derive the minimal product-of-sums expression for the prime BCD-digit detector function of Figure 4-37. Determine whether or not the expression algebraically.

8) A 3-bit "comparator" circuit receives two 3-bit numbers, $P = P_2P_1P_0$ and $Q = Q_2Q_1Q_0$. Design a minimal sum-of-products circuit that produces a 1 output if and only if $P > Q$.