Tutorial _1

1- Simplify the following Boolean expressions to a minimum number of literals:
   a. ABC + A ' B + ABC'
   b. x'yz + xz
   c. (x + y)'(x' + y')
   d. xy + x(wz + wz')

2- Draw the logic diagram of the circuits that implement the original and the simplified expression in problem 1

3- Reduce the following Boolean expressions to the indicated number of literals:
   a. A'C' + ABC + AC' to three literals
   b. (x 'y' + z)' + z + xy + w z to three literals
   c. A'B (D ' + C'D) + B(A + A'C D) to one literal

4- For the Boolean function

F = xy'z+ x'y'z + w'xy + wx'y + wxy

   a. Obtain the truth table of F.
   b. Draw the logic diagram. using the original Boolean expression.
   c. Use Boolean algebra to simplify the function to a minimum number of literals,
   d. Obtain the truth table of the function from the simplified expression and show that it is the same as in part a.

5- Convert each of the following to the other canonical form:
   a. $F(x,y,z) = \Sigma (2,5,6)$
   b. $F(A.B.C,D) = \Pi(0.1.2,4, 7, 9,12)$

6- Express the following function as a sum of minterms and as a product of maxterms:

$$F(A,B,C,D) = B'D + A'D + BD$$

7- Simplify the following Boolean functions. using four-variable maps (use K-map):

a. $F(w, x, y, z) = \Sigma\,(1, 4, 5, 6, 12, 14, 15)$
b. $F(A, B. C. D) = \Sigma\,(1,5, 9, 10, 11, 14, 15)$
c. $F(w, x, y, z) = \Sigma\,(0, 1, 4, 5, 6, 7, 8, 9)$

8- Simplify the following Boolean expressions, using three-variable maps (use K-map):

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

9- Simplify the following Boolean functions to product-of-sums form(use K-map):

a. $F(w, x, y, z) = \Sigma\,(0,1, 2, 5, 8, 10, 13)$
b. $F(A, B, C, D) = \Pi\,(1, 3, 5, 7, 13, 15)$
c. $F(A, B, C, D) = \Pi\,(1, 3, 6, 9, 11,12, 14)$

10- Design a combinational circuit with three input and one output.

a. The output is 1 when the binary value of the inputs is less than 3. the output is 0 otherwise.
b. The output is 1 when the binary value of the input is an odd number.

11- A majority circuit is a combinational circuit whose output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise.

a. Design a three inputs majority circuit by finding the circuits truth table. Boolean equation and a logic diagram.

12- Design an Excess-3 to binary decoder using the unused combinations of the code as don't care conditions.

13- Construct a 5-to 32 line decoder with four 3 -to-8- line decoders with enable and a 2-to-4 line decoder. Use block diagrams for the components.

14- Construct a 4-to-16 line decoder with 2-to-4 line decoders with enable.

15- A combinational circuit is specified by the following three Boolean functions:

a. $F1(A,B,C) = \Sigma(3,5,6)$
b. $F2(A,B,C) = \Sigma(1,4)$
c. $F2(A,B,C) = \Sigma(2,3,5,6,7)$

Implement the circuit with decoder constructed with NAND gates and NAND gates connected to the decoder outputs. Use a block diagram for the decoder.

16- An 8 X 1 multiplexer has inputs A. B, and C connected to the selection inputs S_2, S_1 and S_0, respectively. The data inputs I_0 through I_7 are as follows:

a. $I_1 = I_2 = I_7 = 0$; $I_3 = I_5 = 1$; $I_0 = I_4 = D$; and $I_6 = D'$.
b. $I_1 = I_2 = 0$; $I_3 = I_7 = 1$; $I_4 = I_5 = D$; and $I_0 = I_6 = D'$.

17- Implement the following Boolean function with a 4 X 1 multiplexer and external gates.

a. $F(A, B, C, D) = \Sigma(1, 3, 4, 11, 12, 13, 14, 15)$
b. $F(A, B, C. D) = \Sigma(1, 2, 4, 7, 8, 9, 10, 11, 13, 15)$

Connect Inputs A and B to the selection lines. The input requirements for the four data lines will be a function of variables C and D. These values are obtained by expressing F as a function of C and D for each of the four cases when AB = 00,01, 10 , and 11. The functions may have to be implemented with external gales and with connections to power (1) and ground (0).