ENCS2340 | Section 2 | Fall 2024/2025
Chapter 2
Extra Exercises - 02

1. The Boolean function F is specified as per the truth table opposite.
→ Insert the row index on the table and then express:

X	Y	Z	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

   a. F as a sum of minterms in the canonical shorthand form, i.e. Σm().

   b. F as a product of maxterms in the canonical shorthand form, i.e. ΠM().

   c. Which of the two expressions in (a) and (b) above gives a more optimal (economical) implementation of F?

   d. Express F as a sum of minterms in the canonical algebraic form, i.e. expressed in literals).

   e. Express F as a product of maxterms in the canonical algebraic form, i.e. expressed in literals).

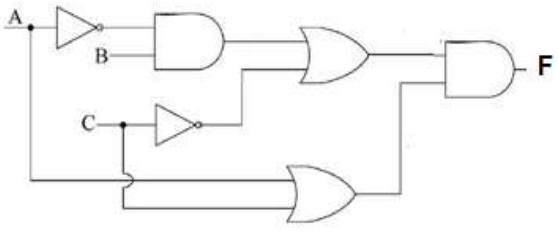
   f. Express $\overline{F}$ as a sum of minterms in the canonical shorthand form, i.e. Σm().

   g. Express $\overline{F}$ as a product of maxterms in the canonical shorthand form, i.e. ΠM().

2. For each of the following functions:
   i. $F(A,B,C) = \Sigma_m(1,2,5,7)$
   ii. $G(A,B,C) = \Pi M(0,2,3,5,6)$

   a. Give the truth table of the functions (put the two functions as two output columns on the same table)
   b. Give the alternative canonical shorthand form for each function (e.g. product of maxterms for a given sum of minterms)
   c. Without using the truth table, express the following new functions in the form specified:
      c.1 F+G as a sum of minterms (shorthand form)
      c.2 F.G as a product of maxterms (shorthand form)
   d. Add two columns showing F+G and F.G to the truth table in (a) above. Verify you got the correct answers in c.

3. For each of the two outputs in the logic diagram below:



   a. The circuit is _____-level logic (how many logic levels)
   Note: consider the critical path and take an inverter as a level)

   b. The logical expression obtained directly from the logic diagram (without any further manipulation) will be in the following form (select one answer):
      - A standard form
      - A canonical form
      - A non-standard form

4. Consider the logic function F(X,Y,Z) = $\overline{X}\,\overline{Z} + Y\overline{Z}(\overline{X} + Y)$ (Eqn. 1)

a. As given, is the function in the 2-level standard form (SOP or POS)?

b. Obtain the truth table for the function as given (show all intermediate steps)

c. From the truth table, express the function in the shorthand forms as:
c.1. a sum of minterms and
c.2. a product of maxterms

d. From the results in c.2 above, express the function as an **algebraic** product of maxterms

e. Algebraically expand the expression for F(X,Y,Z) given in Eqn. 1 above to a sum of minterms and verify that the result matches that of c.1 .

5. Express F(A, B, C) = $A\overline{C} + \overline{B}C$ as an algebraic product of maxterms using:

a. Algebraic manipulations
b. Truth table

Verify that you obtain the same result from (a) and (b) above.

6. For a function of 4 variables F(W,X,Y,Z), complete the following:

a. $W + \overline{X} + \overline{Y} + Z = M_{?}$ b. $\overline{W}\,\overline{X}Y\,\overline{Z} = m_{?}$ c. $M_{12} = G(W,X,Y,Z) =$ _____(algebraic)

d. The product $\overline{X}\,\overline{Y}$ can be expressed as (expanded to) _____ (how many) minterms,
which are _____(algebraic) (maintain the standard order WXYZ)

7. Without using truth tables, check if the following two functions are logically equivalent or not. Show all your work

$F_1(A,B,C) = AB + \overline{A}\,\overline{B}$

$F_2(A,B,C) = \Pi(2,3,4,7)$