Information Technology University of the Punjab
SE201T Digital Logic Design Lab – Fall 2024
Assignment 1 [CLO2]

Deadline: 20th September, 2024 (Start of the Friday class) **Total Marks: 100**

Instructions:

1. Use A4 size sheets to prepare the solution.
2. You must attempt all questions by hand. Use an ink pen or ball point. Word processors are not advised to prepare the solution.
3. Clearly label the start of all questions and their parts. Also, make sure to highlight the final answer in each part.
4. This is an individual assignment so every student must submit their own solution.
5. You can take help from the textbook/reference books. Discussion among peers without showing the solution is acceptable, but you must attempt individually. Plagiarism, if found, will be dealt with according to the ITU anti-plagiarism policy.
6. Make sure to submit it by the deadline. Late submissions will not be accepted.

Q1 [Truth table and Boolean algebra identities]

a. Prove the equivalence of both sides of the following Boolean equations, using truth tables for each side: [10]
   - $AB\bar{C} + B\bar{C}\bar{D} + BC + \bar{C}D = B + \bar{C}D$
   - $WY + \bar{W}Y\bar{Z} + WXZ + \bar{W}X\bar{Y} = WY + \bar{W}X\bar{Z} + \bar{X}Y\bar{Z} + X\bar{Y}Z$

b. Prove the equivalence of each of the above Boolean equations, using algebraic manipulation (name the identity/property used at each step). [10]

Q2 [Minterms and maxterms]

For the Boolean functions E and F, as given in the following truth table:

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

a. List the minterms and maxterms of each function. [4]
b. List the minterms of $\bar{E}$ and $\bar{F}$. [4]
c. List the minterms of $E + F$ and $E \cdot F$. [4]
d. Express E and F in sum-of-minterms algebraic form. [4]
e. Simplify E and F to expressions with a minimum of literals. [4]

Q3 [K-map simplification]

a. Use a Karnaugh map to find the minimum SOP form of each expression:
   - $A\bar{B} + A\bar{B}\bar{C}D + CD + B\bar{C}D + ABCD$ [3]
   - $(\bar{A}\bar{B} + A\bar{B})(\bar{C}\bar{D} + C\bar{D})$ [3]
   - $F(W,X,Y,Z) = \sum m(2,5,6,13,15)\,, d(W,X,Y,Z) = \sum m(0,4,8,10,11)$ [4]

b. Use a Karnaugh map to find the minimum POS form of each expression:

- $F(W,X,Y,Z) = \prod M(5,6,8,12,13,14)$ [3]
- $(\bar{A}+\bar{B}+D)(\bar{A}+\bar{D})(A+B+\bar{D})(A+\bar{B}+C+D)$ [3]
- $F(A,B,C,D) = \sum m(4,6,7,8,12,15)\,,\ d(A,B,C,D) = \sum m(2,3,5,10,11,14)$ [4]

Q4 [Full/complete/minimal sets and gate input cost]

The expression given below has all three operations of AND, OR and NOT:

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

a. Find the following for this expression (no simplification required):
   - AND-NOT complete set equivalent [2]
   - OR-NOT complete set equivalent [2]
   - NAND equivalent [2]
   - NOR equivalent [2]

b. Draw the logic circuit of the original expressions and its above equivalents. [8]

c. Find the gate input cost in each case. Identify the forms that have the least and most gate input cost. [4]

Q5 [Quine-McCluskey method]

Simplify the following Boolean function using the QM technique: [20]

$$F(V,W,X,Y,Z) = \sum m(0,2,4,7,8,10,12,16,18,20,23,24,25,26,27,28)$$