Note: To get the full mark, you need to show all the steps in details (Final answers are not acceptable).

Question 1: Show **algebraically** that the following equation is valid

$$A'BC'D' + (A' + BC) \cdot (A + C'D') + BC'D + A'BC' = ABCD + A'C'D' + ABD + ABCD' + BC'D$$

State which theorem you have used for each step in your work.
(Hint: simplify the LHS first, and then simplify the RHS of the equation.)

Question 2: Simplify the following expression to a minimum number of literals(variables) and terms using boolean algebra theorems

$$ab'cd'e + acd + acf'gh' + abcd'e + acde' + e'h'$$

State which theorem(s) you have used for each step in your work.

Question 3: Design an error detector for $6 - 3 - 1 - 1$ binary-coded-decimal digits. The output (F) is to be 1 **iff** the four inputs (A, B, C, D) represent an invalid code combination.

(a) Build the truth table for the error detector.

(b) Find the min-terms expansion of the function F.

(c) Simplify the function F using <u>Boolean algebra theorems</u> to **two terms**.

(d) Construct the logic circuit of the simplified function F.

Question 4: Given the function $f(a, b, c, d) = a'(b' + d) + acd'$, then:

(a) Find the min-term expansion of the function f.

(b) Find the max-term expansion of the function f.

Question 5: Simplify the following expression to two terms using boolean algebra theorems

$$AB' + A'C'D' + A'B'D + A'B'CD'$$

State which theorem(s) you have used for each step in your work.

Question 6: Simplify the following expression to a minimum number of terms, and at the same time, the simplified expression shall be expressed in POS format. Use boolean algebra theorems.

$$CD + AB' + AC + A'C' + A'B + C'D'$$

State which theorem(s) you have used for each step in your work.

Question 7: Simplify each of the following expressions to a minimum number of terms, and at the same time, each term shall consists of a minimum number of variables. Use boolean algebra theorems.

(a) $XY + X'YZ' + YZ$

(b) $XY' + Z + (X' + Y)Z'$

(b) $(XY' + Z)(X + Y')Z$

State which theorem(s) you have used for each step in your work.
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The problems below are from the Textbook (5th edition):
Question 8. Problem 2.2 (e) and 2.2 (f)
Question 9. Problem 2.8
Question 10. Problem 2.9 (c)
Question 11. Problem 2.13 (c) using NOR only and 2.13 (e) using only NAND
Question 12. Problem 2.17 (d)