QUESTION 1: (50 POINTS)

a) Using the algebraic manipulation, derive the simplest sum-of-products expression for the function
   \[ f(x_1, x_2, x_3, x_4) = (x'_1 + x'_2 + x'_4)(x'_2 + x'_3 + x_4)(x_1 + x'_2 + x'_3). \]

b) Using the Venn diagram, derive the simplest sum-of-products expression for the function
   \[ f(x_1, x_2) = \sum m(1, 3, 4, 6). \]

c) Using the algebraic manipulation, confirm the result you obtained in part (b).

d) Design the simplest function that you have derived in part (b) using only NAND gates.

e) How many NAND gates do you need to synthesize the circuit in part (b)?
**QUESTION 2**: (50 POINTS)
Concerning the following logic circuit, answer the questions.

a) Draw the truth table which shows the logic function \( f \).

b) Derive the canonical POS form of the function \( f \).

c) Implement the function only using NOR gates.

d) Derive the canonical SOP form of the function \( f \); and using the Venn diagram justify that the derived canonical expression may not be simplified any more.