

LAB 1: LOGIC MINIMIZATION

This lab will give you a chance to review the basics of Boolean algebra and implement the Karnaugh Map (K-map) and Quine-McCluskey (tabular) methods to minimize Boolean functions, and to realize said Boolean functions in a logic circuit.

When prompted to implement a circuit, feel free to use Logisim-evolution or CircuitVerse.

Part 1: Boolean Algebra Review

1.A) Equivalent Operations

Consider two functions f and g, of two inputs x and y, with x as the MSB, and y as the LSB:

$$f(x,y) = \sum m(1,2) \quad (1)$$

$$g(x,y) = \prod m(0,3) \quad (2)$$

- a) Draw up the truth tables of f and g. Are f and g equivalent functions? If so, is there a name for this Boolean function?
- b) One of these functions, as expressed, is more naturally implemented as an OR-AND circuit, and the other as an AND-OR circuit. Which is which?
- c) Implement f and g, based on your response in b).

1.B) De Morgan's Theorem

Recall the De Morgan's Theorem:

$$\overline{(a_1 + a_2 + \dots + a_n)} = (\overline{a_1} \cdot \overline{a_2} \cdot \dots \cdot \overline{a_n}) \quad (3)$$

$$\overline{(a_1 \cdot a_2 \cdot \dots \cdot a_n)} = (\overline{a_1} + \overline{a_2} + \dots + \overline{a_n}) \quad (4)$$

- d) Suppose you only have access to NAND and NOR gates. Implement the OR-AND and AND-OR Circuits using only NAND and NOR gates.

Part 2: The K-Map Method

Consider two functions H and L of three inputs x, y, and z, with x as the MSB and z as the LSB.

$$H(x, y, z) = \sum m(1, 2, 4, 5, 6, 7) \quad (5)$$

$$L(x, y, z) = \prod m(3, 5, 6, 7) \quad (6)$$

- a) Draw up a K-map for each of these functions, and minimize them to determine an SOP or POS for each of them.
- b) Implement each of these as OR-AND (for SOPs) or AND-OR circuits (for POSs).

Part 3: The Tabular Method

We will once again use the function H in Part 2.

- a) Before employing the tabular method, attempt to implement H as an AND-OR circuit without grouping and combining any of the implicants.
- b) Construct an Implicant Table for H, and determine the prime implicants of H. Keep track of the minterms covered by each implicant at each stage of the process.
- c) Now, construct an Implicant Chart for H, and determine the SOP of H.
- d) Compare the two implementations for H from this Part, and that of Part 2. Are they the same, or different? Why or why not would that be the case? If they are different, which is the most efficient?