

Q1.

A digital combination lock has three buttons (X, Y, Z). The lock opens (output = O) if the combination is either $X=1, Y=1, Z=0$ OR $X=0, Y=1, Z=1$. Design the circuit using only NAND gates.

- Write the Boolean expression for the combination lock (O).
- Convert the expression to a form suitable for NAND-only implementation.
- Implement the circuit in LogicWorks using only NAND gates.
- Create a truth table and verify that the lock opens only for the correct combinations

Q2

A fire alarm system has three sensors (S1, S2, S3). The alarm should sound (output = A) if any two or more sensors detect a fire. Due to reliability concerns, the system must be implemented using only NOR gates.

- Write the Boolean expression for the fire alarm (A).
- Convert the expression to a form suitable for NOR-only implementation.
- Design the circuit in LogicWorks using only NOR gates.
- Simulate the circuit with various sensor inputs and verify the output using a truth table

Q3 A beverage vending machine accepts four types of coins:

- Q: Quarter (25 cents).
- D: Dime (10 cents).
- N: Nickel (5 cents).
- P: Penny (1 cent).

The machine dispenses a drink (DISPENSE = 1) if the total value of the coins is 30 cents or more.

Since it is difficult to represent 30 exactly with the binary input, we will simplify the problem. The drink should dispense when the following happens.

- Q and D are true.
- Q and N and P are true.
- Q and N are true.
- Find the minimized Boolean expression for DISPENSE using a K-map

Q4.

$$T(X,Y,Z)=\sum m(0,1,3,5,6)$$

Construct a 3-variable K-map.

Minimize the Boolean expression.

Q5:

An elevator system operates based on three inputs: Floor Request (F), Weight Sensor (W), and Emergency Stop (E). The elevator should move ($M = 1$) if:

- A floor request is made, and the weight is within limits.
- The emergency stop is NOT activated.
- Develop a truth table for different input combinations.

- Use K-map to find the simplified logic equation.
- Design a logic circuit based on the minimized expression.

Q6

A digital calculator requires a 4-bit adder to compute the sum of two 4-bit binary numbers.

- Use full adders to design the circuit.
- Create a truth table for the inputs and outputs.
- Draw the block diagram of the circuit.