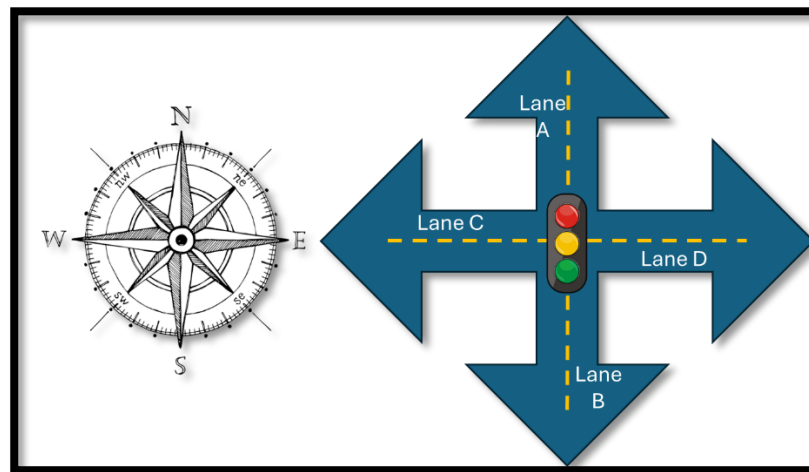


**INSTRUCTIONS**

This is a group assignment of 4 members per group which you must complete and submit. There are 3 questions in total of which you must answer all and the results will contribute 20% of your coursework mark. All assignment submissions **must be handwritten (in legible handwriting)**. Submission could be done either in softcopy or hardcopy.

DUE DATE: 27 June 2025

Late assignment submission will be entitled to 1 mark reduction per day.

**QUESTION 1 [7 Marks]**

You are tasked to design a smart traffic system whereby vehicle-detection sensors are placed along main road (lanes C and D), and access road (lane A and B). These sensors outputs are HIGH (1) when no vehicle is present, and LOW (0) when a vehicle is present.

The intersection traffic light is controlled based on the following rules.

- The east-west (E-W) traffic light is green whenever both lanes C and D are occupied.
- The E-W light will be green whenever either C or D is occupied, regardless of lanes A and B are not occupied or occupied.
- The north-south (N-S) light will be green whenever both lanes A and B are occupied, but lanes C and D are not occupied.
- The N-S light will also be green when either A or B is occupied while C and D are not occupied.
- The E-W light will be green when there are no vehicles on all lanes.

Using the FOUR sensors of A, B, C, and D placed on lanes A, B, C, and D respectively.

TWO outputs of E-W and N-S will go HIGH when the corresponding traffic light is GREEN. Show all steps as follows.

Step 1: Prepare the truth table.

Step 2: Simplification using K-Map

Step 3: Draw the logic circuit based on the simplified Boolean Expression.

### QUESTION 2 [6 Marks]

You are to design a combinational circuit that controls the lights in a room with multiple switches. The requirements are as follows.

There are 3 switches in the room at different sides – one at the front door (A), one at the side door (B) and another at the back door (C)

In the initial state, the room lights are OFF. Additionally, the switch at the back door is OFF whilst the others are ON.

From the initial state, flipping any switch position will turn the lights ON. Flipping any switch position again will turn the lights OFF and so on.

- (i) Draw the truth table for the inputs and outputs above (ii) Derive the final Boolean expression from the truth table.
- (ii) Simplify your Boolean expression (if possible) and then draw the logic circuit for the switch controls in the room

### QUESTION 3 [7 Marks]

Design a magnitude comparator that takes two 2-bit binary numbers, A2A1 and B2B1, and determine their status based on the condition below,

- If two numbers are equal, then EQUAL = 0
- If A2A1 is greater than B2B1, then GREATER = 0
- If A2A1 is less than B2B1, then LESS = 0

This comparator circuit contains FOUR inputs (A2A1 and B2B1) and THREE outputs (EQUAL, GREATER and LESS).

- i. Derive the truth table for the above problem.
- ii. Minimized the expression into simplified SOP form using K-map.
- iii. Draw the combinational logic diagram based on the simplified Boolean expression as in (ii).