Step 1: Understand and Define the Problem (Analyse)

We need to design a **combinational logic circuit** that activates a **LOW-level alarm signal (ALARM = 0)** when:

- The **car ignition (IGN)** is ON, **and**

- Either the **driver (DRIV)** or **passenger (PASS)** seat is occupied, **and**

- The corresponding **seatbelt (BELTD or BELTP)** is **not fastened**.

This means:

- If the driver is seated but their belt is not fastened → Alarm ON.

- If the passenger is seated but their belt is not fastened (while driver is present) → Alarm ON.

- In all other cases → Alarm OFF.

Step 2: Organize and Describe the Data

Inputs:

- **DRIV** = 1 if driver seated, 0 otherwise.

- **PASS** = 1 if passenger seated, 0 otherwise.

- **BELTD** = 1 if driver belt fastened, 0 if not.

- **BELTP** = 1 if passenger belt fastened, 0 if not.

- **IGN** = 1 if ignition ON, 0 otherwise.

Output:

- **ALARM** = 0 (ON), 1 (OFF)

Step 3: Design the Solution

3.1 Algorithm (Plain English)

1. Check if ignition is ON.

2. If driver is in seat and driver's belt is not fastened → Alarm ON.

3. If passenger is in seat and passenger's belt is not fastened → Alarm ON.
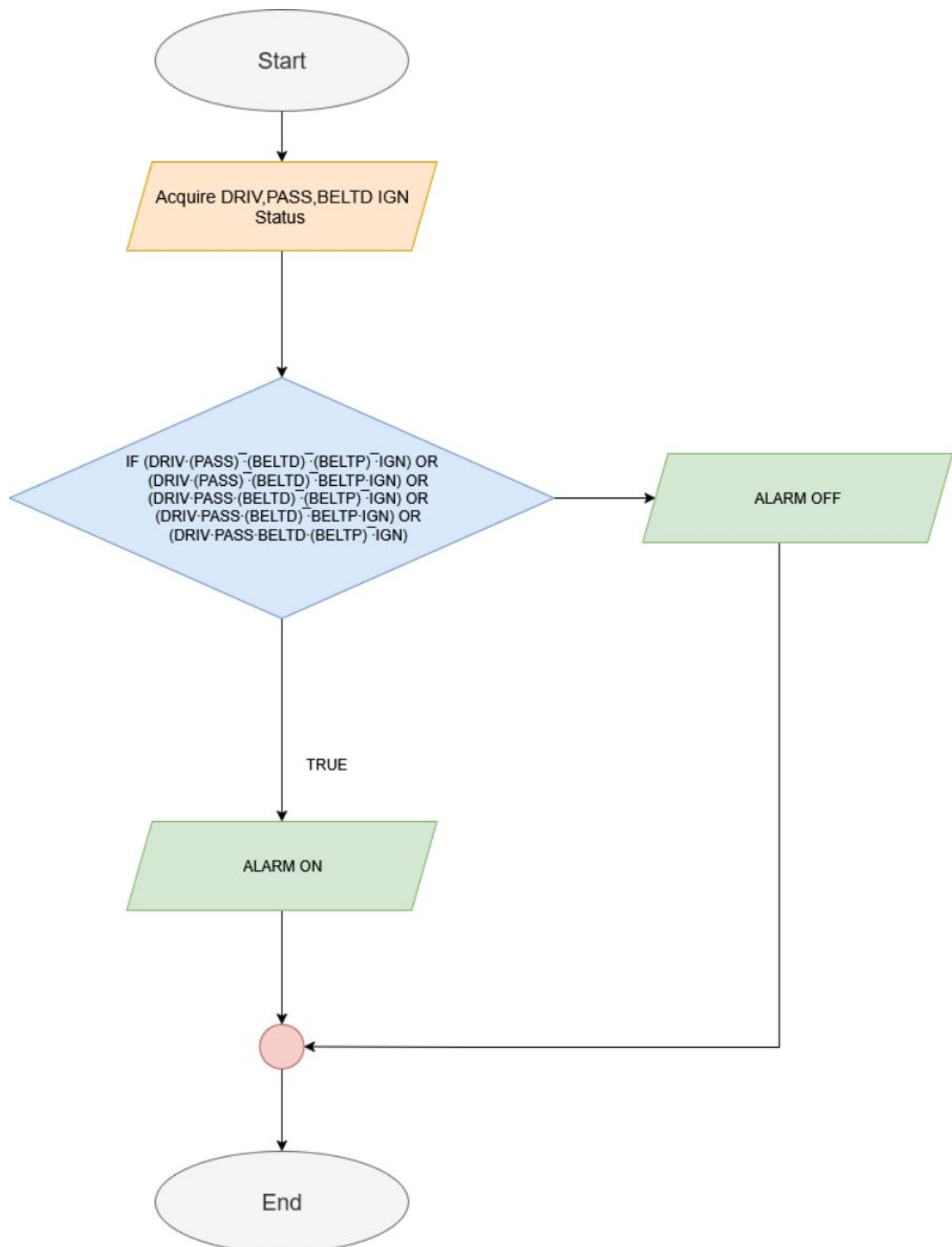
4. Otherwise → Alarm OFF.

3.2 Truth Table

DRIV	PASS	BELTD^	BELTP^	IGN	ALARM^
0	0	0	0	1	1
0	0	0	1	1	1
0	0	1	0	1	1
0	0	1	1	1	1
0	1	0	0	1	1
0	1	0	1	1	1
0	1	1	0	1	1
0	1	1	1	1	1
1	0	0	0	1	0
1	0	0	1	1	0
1	0	1	0	1	1
1	0	1	1	1	1
1	1	0	0	1	0
1	1	0	1	1	0
1	1	1	0	1	0
1	1	1	1	1	1

3.3 Boolean Expression

$$\text{ALARM} = [(\text{DRIV} \cdot \overline{\text{BELTD}} \cdot) + (\text{PASS} \cdot \overline{\text{BELTP}})] \cdot \text{IGN}$$

Alarm is **active LOW** (0 when triggered).

3.4 Flowchart

Start

Acquire DRIV,PASS,BELTD IGN Status

IF (DRIV·(PASS)⁻(BELTD)⁻(BELTP)⁻IGN) OR
(DRIV·(PASS)⁻(BELTD)⁻BELTP·IGN) OR
(DRIV·PASS·(BELTD)⁻(BELTP)⁻IGN) OR
(DRIV·PASS·(BELTD)⁻BELTP·IGN) OR
(DRIV·PASS·BELTD·(BELTP)⁻IGN)

ALARM OFF

TRUE

ALARM ON

End

3.5 Pseudocode

IF (DRIV $\cdot$ $\overline{(PASS)}$ $\cdot$ $\overline{(BELTD)}$ $\cdot$ $\overline{(BELTP)}$ $\cdot$ IGN) OR

(DRIV $\cdot$ $\overline{(PASS)}$ $\cdot$ $\overline{(BELTD)}$ $\cdot$ BELTP $\cdot$ IGN) OR

(DRIV $\cdot$ PASS $\cdot$ $\overline{(BELTD)}$ $\cdot$ $\overline{(BELTP)}$ $\cdot$ IGN) OR

(DRIV $\cdot$ PASS $\cdot$ $\overline{(BELTD)}$ $\cdot$ BELTP $\cdot$ IGN) OR

THEN ALARM = 0 # ON

ELSE ALARM = 1 # OFF