A. *Boolean Logic Table, operation and circuit design for System Functionality*

Gas Sensor (G)	LED Output (L)	Buzzer Output (B)	System Status
0 (< 250)	0	0	Safe
1 (≥ 250)	1	1	Gas Alert

Entry Distance < 50	Exit Distance < 50	Entry Gate (EG)	Exit Gate (XG)
0	0	0	0
0	1	0	1
1	0	1	0
1	1	1	1

Case	Gas (G)	Free Slots (FS)	Entry (E)	Exit (X)	LED (L)	Gas Buzzer (GB)	Full Buzzer (FB)	Entry Gate (EG)	Exit Gate (XG)	LCD Display	System Description
1	0	>0	0	0	0	0	0	0	0	"Free Slots: [list]"	Normal operation, slots available
2	0	0	0	0	0	0	1	0	0	"Parking Full"	Parking full, no entry/exit
3	1	>0	0	0	1	1	0	0	0	"Free Slots: [list]"	Gas alert with available slots
4	1	0	0	0	1	1	1	0	0	"Parking Full"	Gas alert + parking full

Case	Gas (G)	Free Slots (FS)	Entry (E)	Exit (X)	LED (L)	Gas Buzzer (GB)	Full Buzzer (FB)	Entry Gate (EG)	Exit Gate (XG)	LCD Display	System Description
5	0	>0	1	0	0	0	0	1	0	"Free Slots: [list]"	Vehicle entering
6	0	>0	0	1	0	0	0	0	1	"Free Slots: [list]"	Vehicle exiting
7	0	>0	1	1	0	0	0	1	1	"Free Slots: [list]"	Simultaneous entry/exit
8	0	0	1	0	0	0	1	1	0	"Parking Full"	Entry attempt when full
9	0	0	0	1	0	0	1	0	1	"Parking Full"	Exit when full
10	1	>0	1	0	1	1	0	1	0	"Free Slots: [list]"	Gas alert + vehicle entering
11	1	>0	0	1	1	1	0	0	1	"Free Slots: [list]"	Gas alert + vehicle exiting
12	0	>0	1	1	0	0	0	1	1	"S[#] Billed"	Vehicle exit with billing
13	1	0	1	0	1	1	1	1	0	"Parking Full"	Gas alert + entry when full
14	1	0	0	1	1	1	1	0	1	"Parking Full"	Gas alert + exit when full
15	1	>0	1	1	1	1	0	1	1	"S[#] Billed"	Gas alert + exit with billing

Row	Gas (G)	Slots Free (SF)	Buzzer (B)	LCD Display
1	0	>0	0	"Free Slots: [list]"
2	0	0	1	"Parking Full"
3	1	>0	0	"Free Slots: [list]"
4	1	0	1	"Parking Full"
5	0	>0	0	"Free Slots: [list]"
6	0	>0	0	"Free Slots: [list]"
7	0	>0	0	"Free Slots: [list]"
8	0	0	1	"Parking Full"
9	0	0	1	"Parking Full"
10	0	0	1	"Parking Full"
11	1	>0	0	"Free Slots: [list]"
12	1	>0	0	"Free Slots: [list]"
13	1	>0	0	"Free Slots: [list]"
14	1	0	1	"Parking Full"
15	1	0	1	"Parking Full"

Test Case	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Gas Detected	Free Slot	Gate Entry	Gate Exit	LCD	Buzzer	LED
1	1	1	1	1	1	1	0	6	Open	Open	Free Slots: 1,2,3,4,5,6	OFF	OFF
2	1	1	1	1	1	1	1	6	Open	Open	Gas Alert	ON	ON
3	0	1	1	1	1	1	0	5	Open	Open	Free Slots: 2,3,4,5,6	OFF	OFF
4	0	1	1	1	1	1	1	5	Open	Open	Gas Alert	ON	ON
5	0	0	0	1	1	1	0	3	Open	Open	Free Slots: 4,5,6	OFF	OFF
6	0	0	0	1	1	1	1	3	Open	Open	Gas Alert	ON	ON

7	0	0	0	0	0	0	0	0	Close	Open	Parking Full	ON	OFF
8	0	0	0	0	0	0	1	0	Close	Open	Gas Alert	ON	ON
9	1	0	1	0	1	0	0	3	Open	Open	Free Slots: 1,3,5	OFF	OFF
10	1	0	1	0	1	0	1	3	Open	Open	Gas Alert	ON	ON
11	1	1	1	1	1	0	0	5	Open	Open	Free Slots: 1,2,3,4,5	OFF	OFF
12	1	1	1	1	1	0	1	5	Open	Open	Gas Alert	ON	ON
13	0	0	0	0	0	1	0	1	Open	Open	Free Slots: 6	OFF	OFF
14	0	0	0	0	0	1	1	1	Open	Open	Gas Alert	ON	ON

15	0	0	0	0	1	0	0	1	Open	Open	Free Slots: 5	OFF	OFF
16	0	0	0	0	1	0	1	1	Open	Open	Gas Alert	ON	ON
17	0	0	0	0	1	1	0	2	Open	Open	Free Slots: 5,6	OFF	OFF
18	0	0	0	0	1	1	1	2	Open	Open	Gas Alert	ON	ON
19	0	0	0	1	0	0	0	1	Open	Open	Free Slots: 4	OFF	OFF
20	0	0	0	1	0	0	1	1	Open	Open	Gas Alert	ON	ON
21	0	0	0	1	0	1	0	2	Open	Open	Free Slots: 4,6	OFF	OFF
22	0	0	0	1	0	1	1	2	Open	Open	Gas Alert	ON	ON
23	0	0	0	1	1	0	0	2	Open	Open	Free Slots: 4,5	OFF	OFF
24	0	0	0	1	1	0	1	2	Open	Open	Gas Alert	ON	ON
25	0	0	1	0	0	0	0	1	Open	Open	Free Slots: 3	OFF	OFF

26	0	0	1	0	0	0	1	1	Open	Open	Gas Alert	ON	ON
27	0	0	1	0	0	1	0	2	Open	Open	Free Slots: 3,6	OFF	OFF
28	0	0	1	0	0	1	1	2	Open	Open	Gas Alert	ON	ON
29	0	0	1	0	1	0	0	2	Open	Open	Free Slots: 3,5	OFF	OFF
30	0	0	1	0	1	0	1	2	Open	Open	Gas Alert	ON	ON
31	0	0	1	0	1	1	0	3	Open	Open	Free Slots: 3,5,6	OFF	OFF
32	0	0	1	0	1	1	1	3	Open	Open	Gas Alert	ON	ON

➤ *Boolean Expression of Truth Tables Demonstrating Smart Parking System*

The smart parking system is designed to open the gate only when it is safe and feasible to allow vehicle entry. Safety is ensured by checking for toxic gas presence, and feasibility is ensured by verifying the availability of at least one free parking slot.

For this system, the gate will open under the following conditions:
No gas is detected ($\neg F$),
At least one slot is free ($S1 \lor S2 \lor S3 \lor S4 \lor S5 \lor S6$),
A vehicle is detected at the entry point (E).

This ensures that the gate never opens when:
- Gas levels are dangerous,
- All parking slots are occupied,
- No vehicle is detected at the gate.

➤ *Final Boolean Expression*

$Y = (\neg F \land (S1 \lor S2 \lor S3 \lor S4 \lor S5 \lor S6) \land E$) -- *(1)*
Where:
Y = Gate open signal (1 = open, 0 = closed)

F = Gas detected (1 = dangerous gas present)
Si = Slot i is free (1 = free, 0 = occupied), i = 1 to 6
E = Vehicle detected at entry

➤ *Full Parking Condition Expression*

If all parking slots are occupied, the system will:
Display "FULL" on LCD
Activate the buzzer
Z = (¬S1 ∧ ¬S2 ∧ ¬S3 ∧ ¬S4 ∧ ¬S5 ∧ ¬S6) *--(2)*
Where:
Z = "FULL" status (1 = all full, 0 = space available)

➤ *Symbol Interpretation of Above Boolean Expressions*

In the above expressions (1), (2):
- ¬ → NOT Operation
- ∧ → AND Operation (All conditions must be TRUE)
- ∨ → OR Operation (At least one condition must be TRUE)

➤ *Logic Circuit Diagram Demonstrating above Boolean expressions*

$$Y = (¬F \wedge (S1 \vee S2 \vee S3 \vee S4 \vee S5 \vee S6) \wedge E)$$
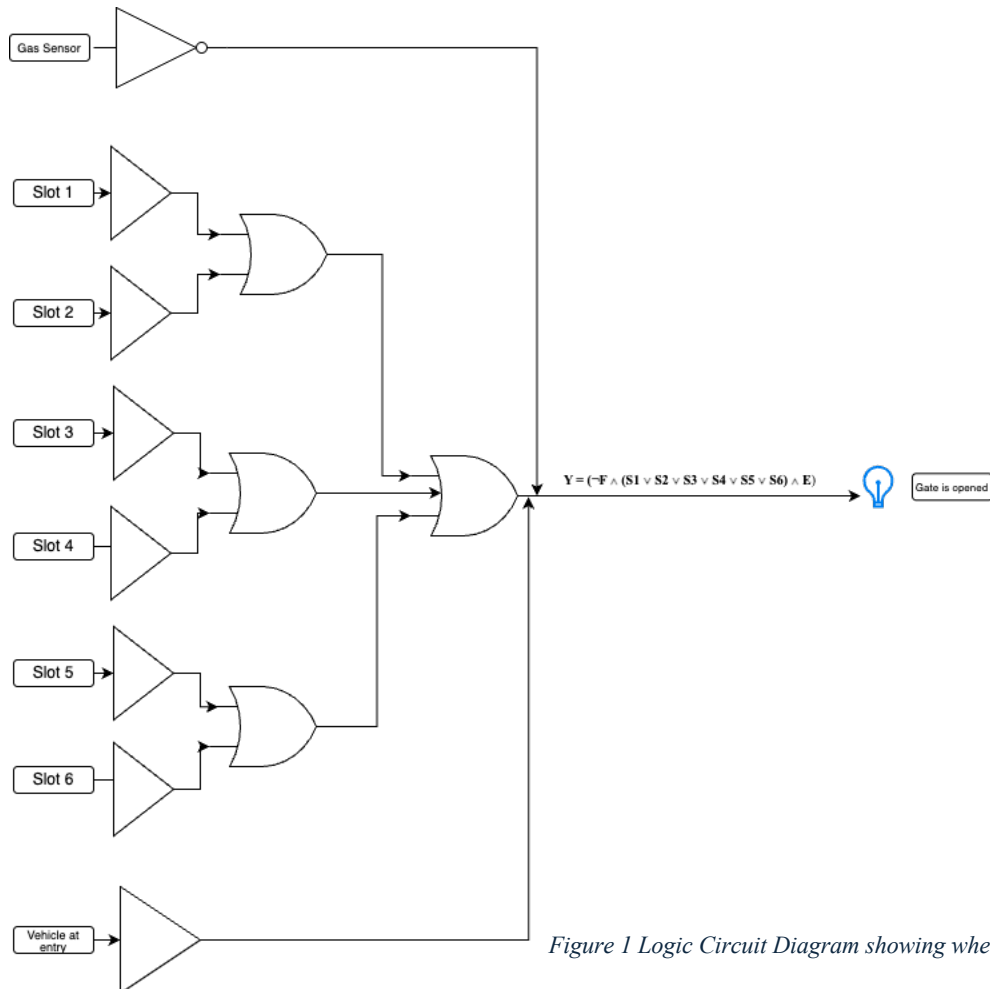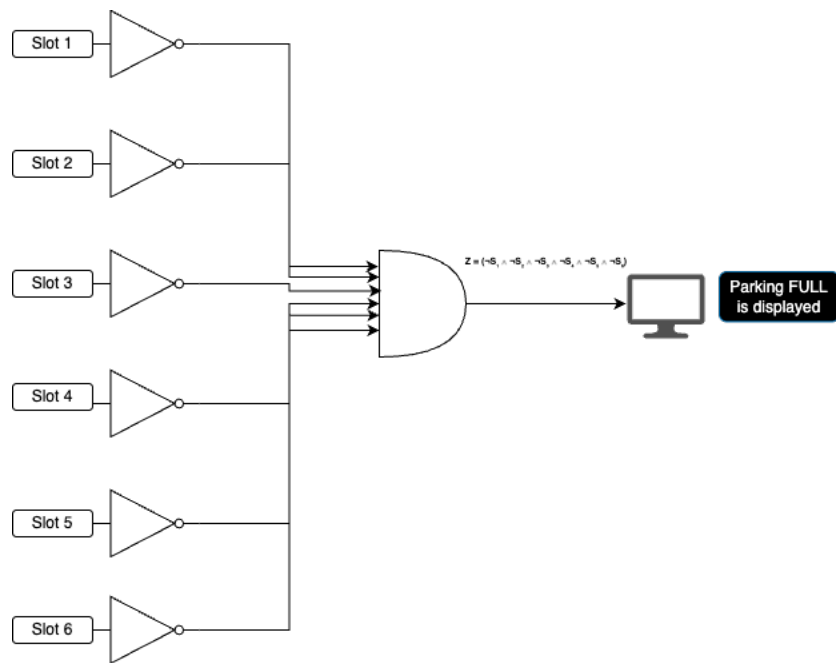
Figure 1 Logic Circuit Diagram showing when Gate opens

Figure 2. Logic Circuit Diagram showing when parking is Full