CSCE 312 – Lab 3 Report

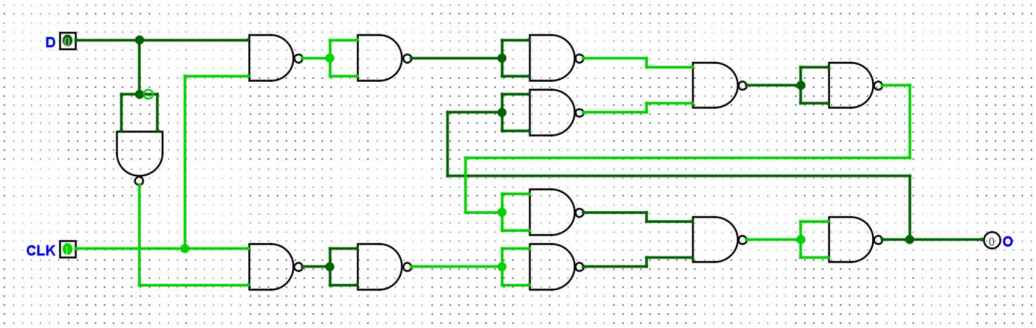
Texas A&M University

February 13, 2024

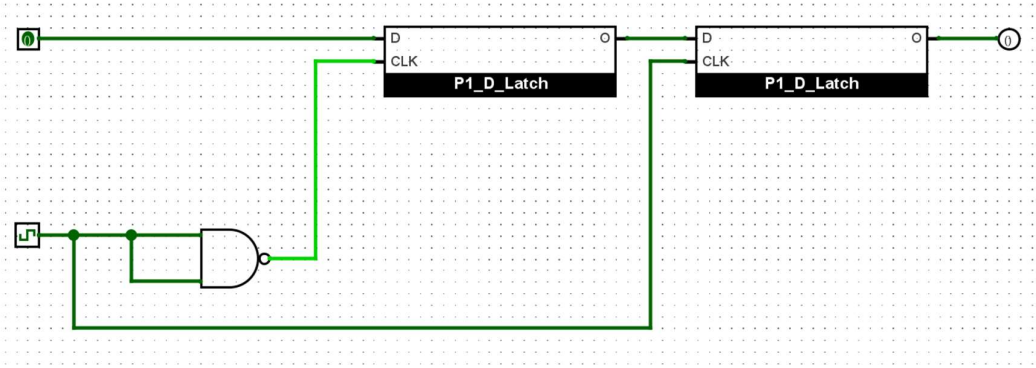
Poyi Ou

Problem 1:

a. D-Latch using NAND Gate



b. D-Flip Flop using two D-Latch

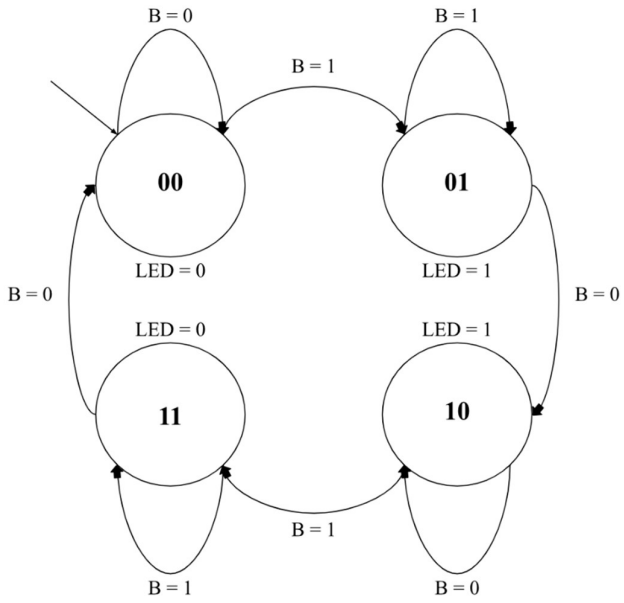


Problem 2:

1. **Definition of SPST and NO in electro-mechanical switches**
   SPST stands for Single Pole, Single Throw, representing a switch with two terminal connections: Normally Open (NO) and Common (C). The term 'Normally Open (NO)' indicates that in the resting state of the switch, there is no electrical connection between the Common (C) and Normally Open (NO) terminals. Therefore, when the SPST switch is activated, the circuit closes, allowing current to flow from the Common (C) terminal to the Normally Open (NO) terminal. Conversely, when the circuit is not activated, it remains open, creating an open circuit. The invention of the SPST switch has simplified design processes, made setups and wiring easier, and requiring less cabling.

2. Digital Circuit Design

a. Finite State Machine



b. Truth Table

S_1	S_0	B	LED	N_1	N_0
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	1	1	0
0	1	1	1	0	1
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	0	0	0
1	1	1	0	1	1

c. Equation

$LED = S_1'S_0B' + S_1'S_0B + S_1S_0'B' + S_1S_0'B$

$N_1 = S_1'S_0B' + S_1S_0'B' + S_1S_0'B + S_1S_0B$

$N_0 = S_1'S_0'B + S_1'S_0B + S_1S_0'B + S_1S_0B$

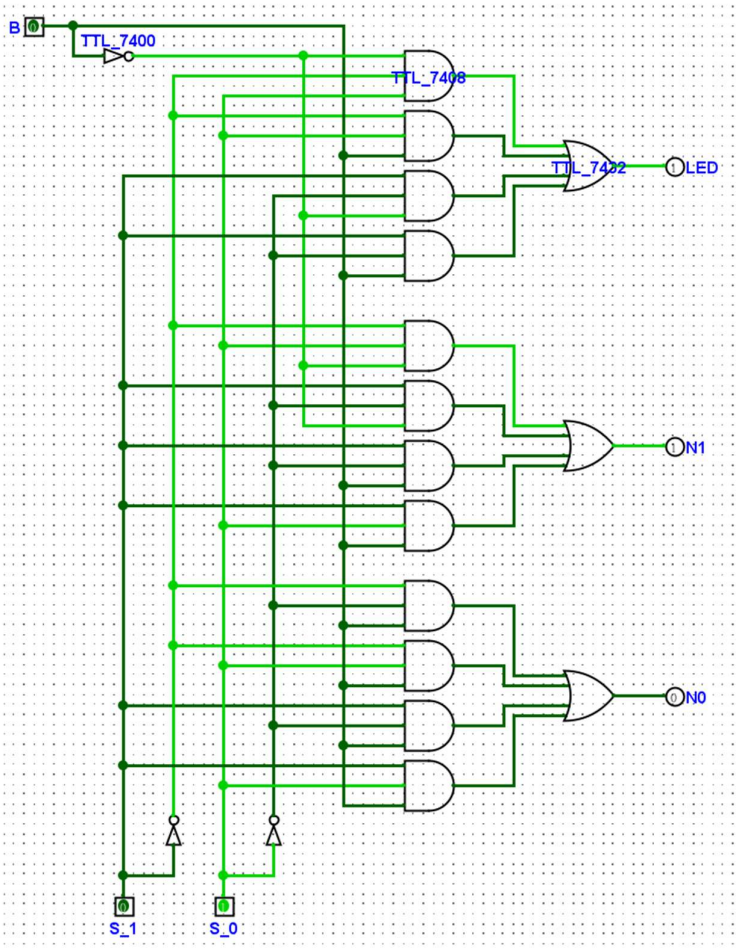
3. TTL ICs Used

For the circuit I designed for this problem, I utilized 12 3-input AND gates, 3 4-input OR gates, and 3 NOT gates, which can be substituted with TTL-7408, TTL-7432, and TTL-7400, respectively.

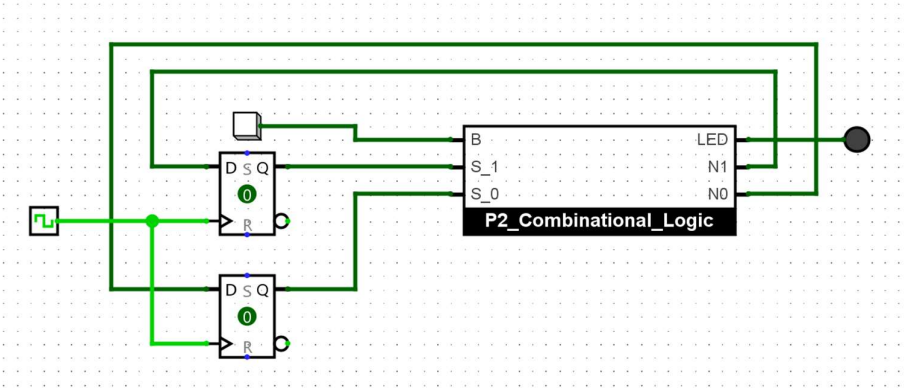
*Note: We can recreate NOT gates by using the TTL-7400 2-input NAND gate and connecting the same wire to two different inputs.

4. Final Circuit Designs

a. Combinational Logic Design



b. Controller Circuit Design



Problem 3:

1. **Circuit Designs**
    a. **Truth table for Load Signals**

B2	B1	B0	I/O Enable	Head Light	D1	D2	D3	D4	Left Light	Right Light	Wipers
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	**1**	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0
0	0	1	1	0	**1**	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0
0	1	0	1	0	0	**1**	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0	0
0	1	1	1	0	0	0	**1**	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	**1**	0	0	0
1	0	1	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	**1**	0	0
1	1	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0	**1**	0
1	1	1	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0	**1**

*B3 is not included, as when B3 is 0, the output remains unchanged.

    b. **Simplified equation for the truth tables above:**

Headlight = B2’B1’B0’(I/O)

D1 = B2’B1’B0(I/O)

D2 = B2’B1B0’(I/O)

D3 = B2’B1B0(I/O)

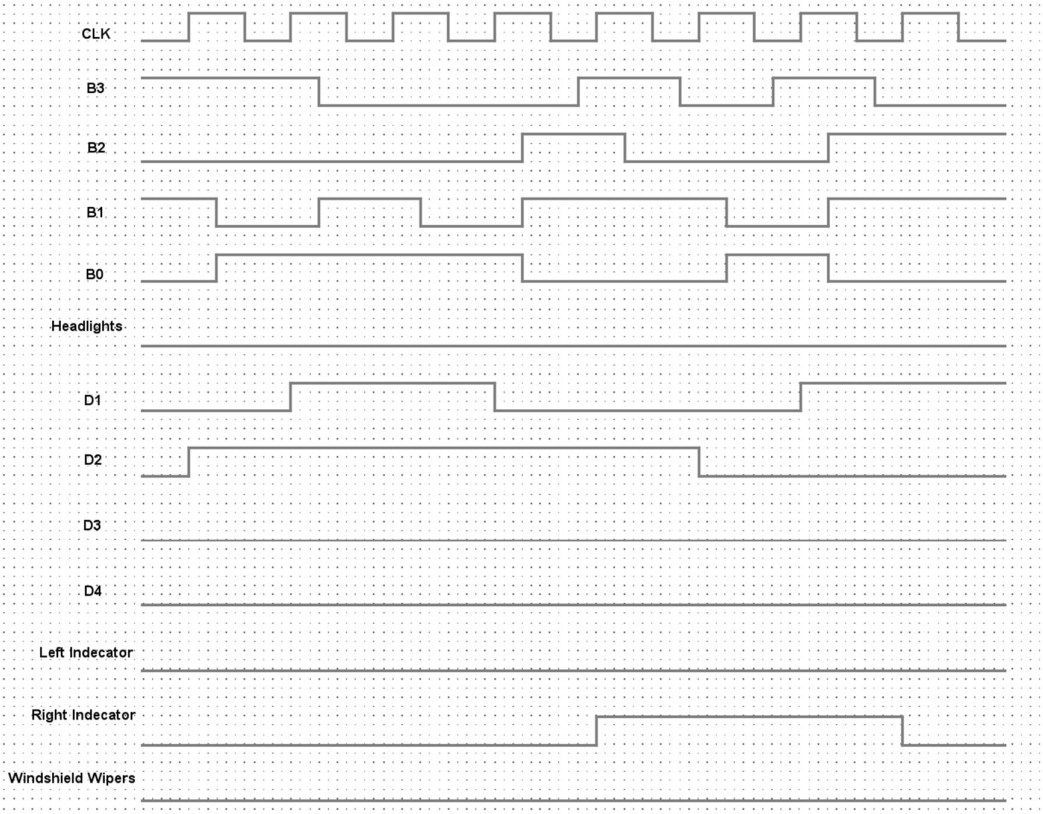
D4 = B2B1’B0’(I/O)

Left Light = B2B1’B0(I/O)

Right Light = B2B1B0’(I/O)

Wiper = B2B1B0(I/O)

2. Timing Diagram



3. Circuit Design Result