Lab 6: Finite State Machines

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1 Part I

1. Complete Table 1 below.

Table 1: State Encodings

State	Encoding
A	0000001
B	0000010
C	0000100
D	0001000
E	0010000
F	0100000
G	1000000

2. Complete Table 2 below.

Table 2: Encoded State Transition Table for Robo-Snail

Current State	W	Next State
0000000 (Reset)	1	0000001
0000001	0	0000001
0000001	1	0000010
0000010	0	0000001
0000010	1	0000100
0000100	0	0010000
0000100	1	0001000
0001000	0	0010000
0001000	1	0100000
0010000	0	0000001
0010000	1	1000000
0100000	0	0010000
0100000	1	0100000
1000000	0	0000001
1000000	1	0000100

3. Derive equations for each of your next state outputs below.

$$
\begin{aligned}
S_0' &= S0 \cdot \overline{W} + S1 \cdot \overline{W} + S4 \cdot \overline{W} + S6 \cdot \overline{W} + Reset \cdot W \\
S_1' &= S0 \cdot W \\
S_2' &= S1 \cdot W + S6 \cdot W \\
S_3' &= S2 \cdot W \\
S_4' &= S3 \cdot \overline{W} + S2 \cdot \overline{W} + S5 \cdot \overline{W} \\
S_5' &= S3 \cdot W + S5 \cdot W \\
S_6' &= S4 \cdot W
\end{aligned}
$$

4. Export the subcircuit schematic as an image and include it in your report.

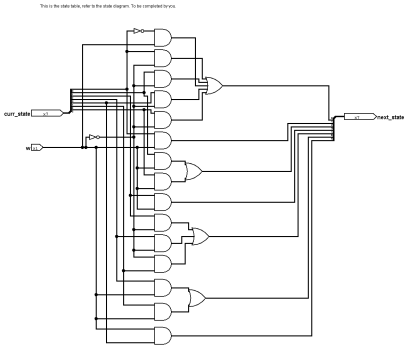

Figure 1: A schematic of part1_state_table.

5. Complete Table 3 below.

Table 3: Encoded Output Table for Robo-Snail

State	Output
0000000 (Reset)	0
0000001 (S0)	0
0000010 (S1)	0
0000100 (S2)	0
0001000 (S3)	0
0010000 (S4)	0
0100000 (S5)	1
1000000 (S6)	1

6. Derive the equation for your output logic below.

$$Z = S5 + S6$$

7. Export the subcircuit schematic as an image and include it in your report.

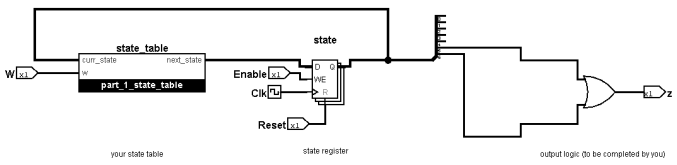

Figure 2: A schematic of part1_FSM.

2 Part II

1. Complete Table 4 below.

Table 4: Encoded State Transition Table for Part II

State	ld_a	ld_b	ld_c	ld_x	alu_select_a	alu_select_b	alu_op	ld_alu_out	ld_r
0000	1	0	0	0	00	00	0	0	0
0001	0	1	0	0	00	00	0	0	0
0011	0	0	1	0	00	00	0	0	0
0010	0	0	0	1	00	00	0	0	0
0110	0	1	0	0	10	01	1	1	0
0111	0	1	0	0	01	00	0	1	0
0101	1	0	0	0	11	10	1	1	0
0100	1	0	0	0	00	10	1	1	0
1100	0	0	0	0	00	01	0	0	1

2. Draw the state transition diagram and include it in Figure 3.

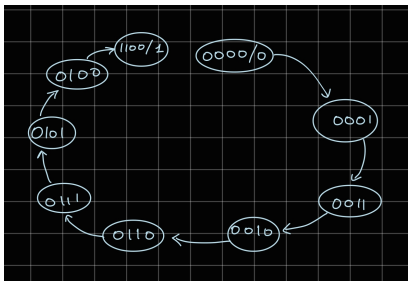

Figure 3: The state transition diagram for Part II

3. Simulate your circuit using a variety of input settings.

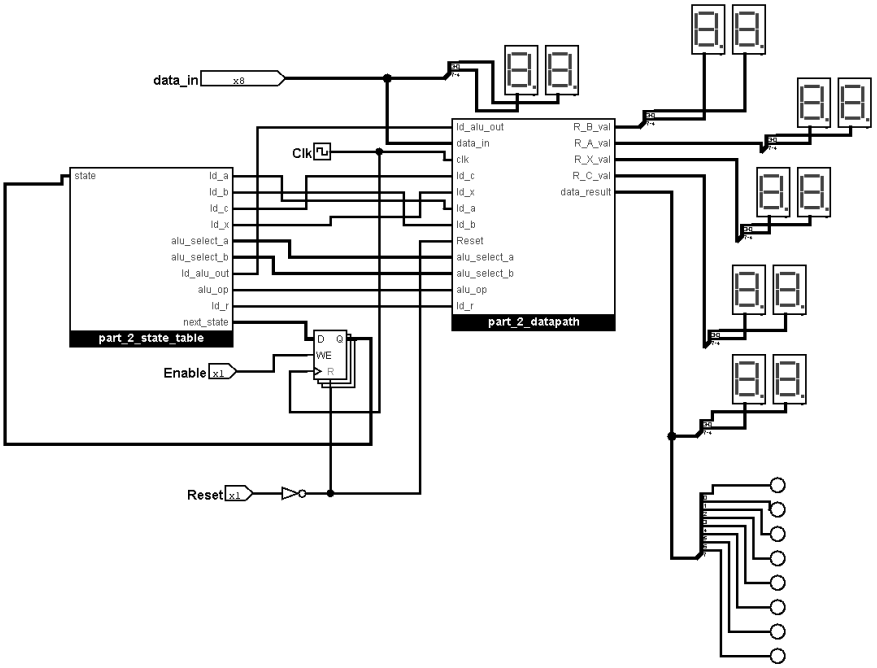

Figure 4: Test Case for Part 2.

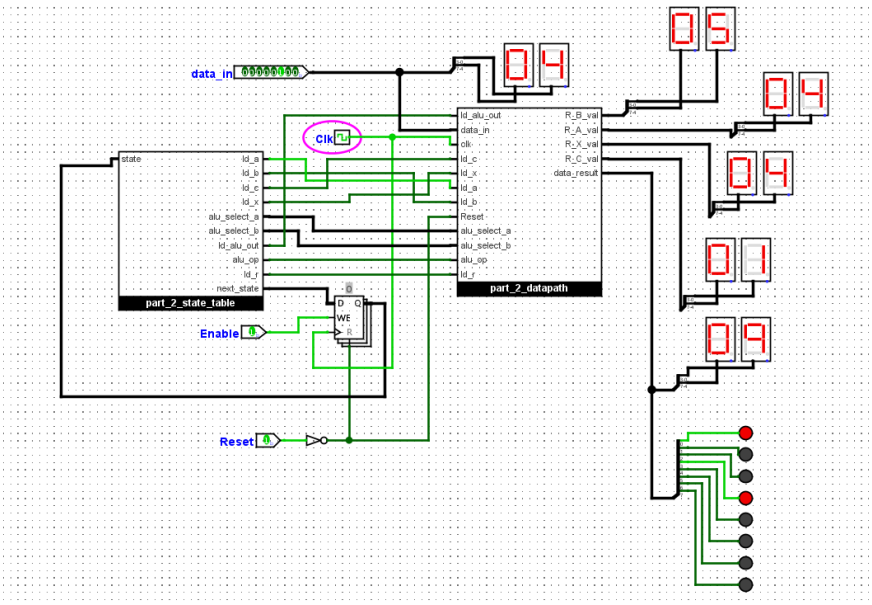

Figure 5: Test Case for Part 2.

3 Part III

1. Draw a schematic for the datapath of your circuit. It will be similar to the handout. You should show how you will initialize the registers, where the outputs are connected, and include all the control signals that you require.
2. Draw the state diagram that controls your datapath.

Figure 6: State diagram that controls the datapath in Part 3.

3. Draw the schematic for your controller module.

Figure 7: Controller Module in Part III.

4. Draw the top-level schematic showing how the datapath and controller are connected as well as the inputs and outputs to your top-level circuit.

Figure 8: Top level schematics schematic in Part III.

5. Simulate your circuit using a variety of input settings.

Figure 9: Test Case for Part 3.

Figure 10: Test Case for Part 3.