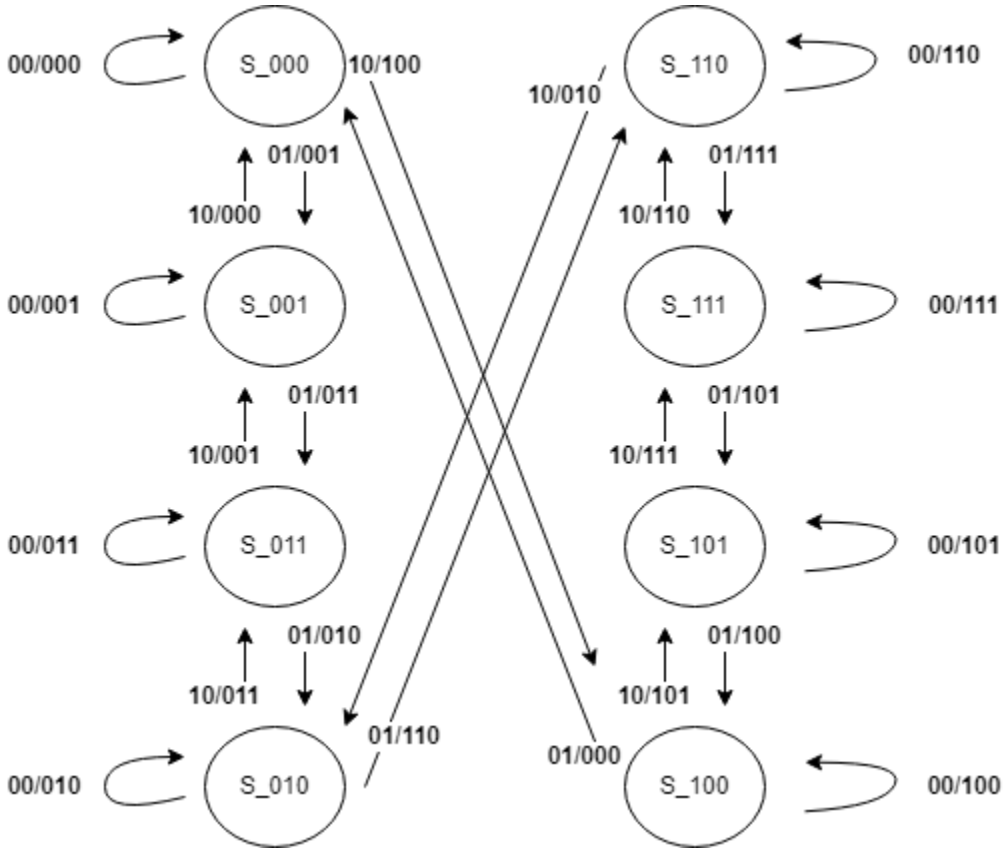
# CS 20 Laboratory 8: Sequential Circuit Design

1. (2pt) Mealy state diagram




2. (2pt) State table

| | Present Input ($x_1x_2$) | | | | |
|---|---|---|---|---|---|
| | | 00 | 01 | 11 | 10 |
| Present State ($S\_q_1q_2q_3$) | S_000 | S_000, 000 | S_001, 001 | X | S_100, 100 |
| | S_001 | S_001, 001 | S_011, 011 | X | S_000, 000 |
| | S_011 | S_011, 011 | S_010, 010 | X | S_001, 001 |
| | S_010 | S_010, 010 | S_110, 110 | X | S_011, 011 |
| | S_110 | S_110, 110 | S_111, 111 | X | S_010, 010 |
| | S_111 | S_111, 111 | S_101, 101 | X | S_110, 110 |
| | S_101 | S_101, 101 | S_100, 100 | X | S_111, 111 |
| | S_100 | S_100, 100 | S_000, 000 | X | S_101, 101 |

3. (4pts) Table with present state, current input, next state, and output.

| Current input | | Present State | | | Next State | | | Output | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $x_1$ | $x_2$ | $q_1$ | $q_2$ | $q_3$ | $q_1+$ | $q_2+$ | $q_3+$ | $y_1$ | $y_2$ | $y_3$ |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | X | X | X | X | X | X |
| 1 | 1 | 0 | 0 | 1 | X | X | X | X | X | X |
| 1 | 1 | 0 | 1 | 0 | X | X | X | X | X | X |
| 1 | 1 | 0 | 1 | 1 | X | X | X | X | X | X |
| 1 | 1 | 1 | 0 | 0 | X | X | X | X | X | X |
| 1 | 1 | 1 | 0 | 1 | X | X | X | X | X | X |
| 1 | 1 | 1 | 1 | 0 | X | X | X | X | X | X |
| 1 | 1 | 1 | 1 | 1 | X | X | X | X | X | X |

4. (3pts) Minimized sum-of-product K-maps of the following:

   a. (1pt) Output bit y1.

| $x_1 x_2$ \ $q_1 q_2 q_3$ | 000 | 001 | 011 | 010 | 110 | 111 | 101 | 100 |
|---|---|---|---|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 01 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 11 | X | X | X | X | X | X | X | X |
| 10 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

SOP expression of $y_1$: **x1'x2'q1 + x2q2q3' + q1q3 + x1q2'q3'**

   b. (1pt) Output bit y2.

| $x_1 x_2$ \ $q_1 q_2 q_3$ | 000 | 001 | 011 | 010 | 110 | 111 | 101 | 100 |
|---|---|---|---|---|---|---|---|---|
| 00 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| 01 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 11 | X | X | X | X | X | X | X | X |
| 10 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |

SOP expression of $y_2$: **x1'x2'q2 + x2q1'q3 + q2q3' + x1q1q3**

c. (1pt) Output bit y3.

| $x_1$ $x_2$ | $q_1$ $q_2$ $q_3$ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 000 | 001 | 011 | 010 | 110 | 111 | 101 | 100 |
| 00 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 01 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 11 | X | X | X | X | X | X | X | X |
| 10 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

SOP expression of $y_3$: **x1'x2'q3 + x2q1'q2' + x1q1'q2 + x2q1q2 + x1q1q2'**