## Exam Ground Rules

- Exam is on Canvas
- Don't need to show up to room
- I will be on class Zoom to answer questions
- Held during class
- Exam opens @ 8:55 w/ 60 minutes
  due @ 10:15
- 1 3x5 card
- Free response save as PDF -20% penalty for email

# Exam Review

Ch1 Numbers: 2's complement ⟷ Decimal

Ch4 Combinational Building Blocks

- Mux
- Decoder
- Comparators
- Adder/Subtractor

} I/O behavior
Build big from smaller
Internal structure
Combinations } If/then
Behavior
Glue Logic

Ch5 Basic Memory Elements

| When \ How | D | T | SR | JK |
|---|---|---|---|---|
| L | | | | |
| CL | | | | |
| FF | | | | |

Timing Diagrams

Ch6 Sequential Building Blocks

- Register
- Shift register
- Counter
- RAM

I/O behavior
Internal structure
Combinations
Behavior } Timing
Glue logic }

Provide

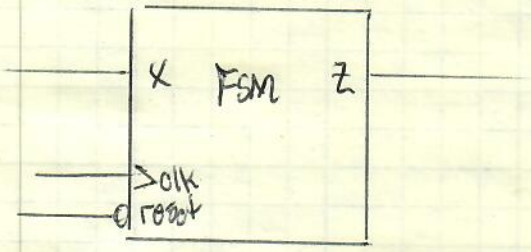
- Truth tables for sequential control of BBB

State Diagram

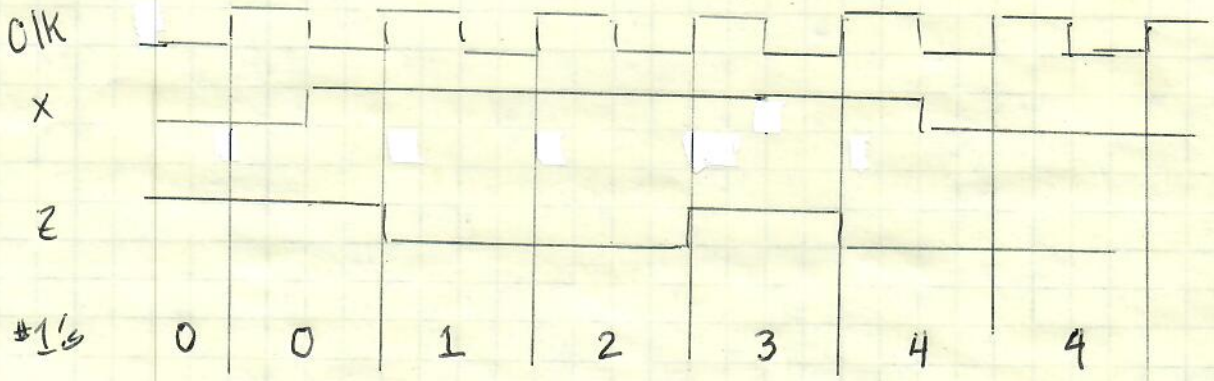
State

History of previous inputs
Operating Mode of a system
Step in a process

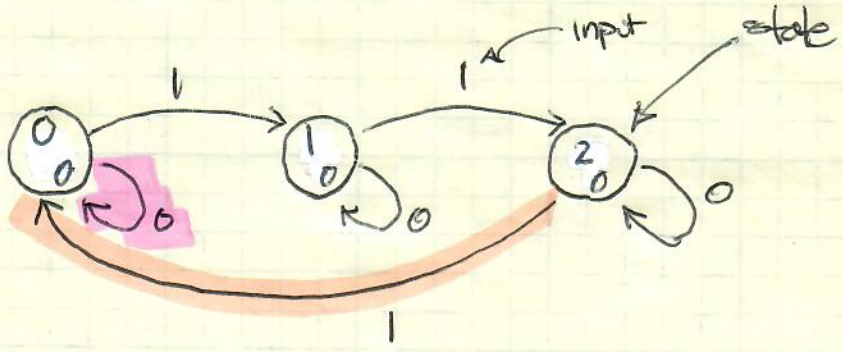
Build a FSM which outputs 1 when the number of 1's seen is a multiple of 3. Note 0 is a multiple of 3

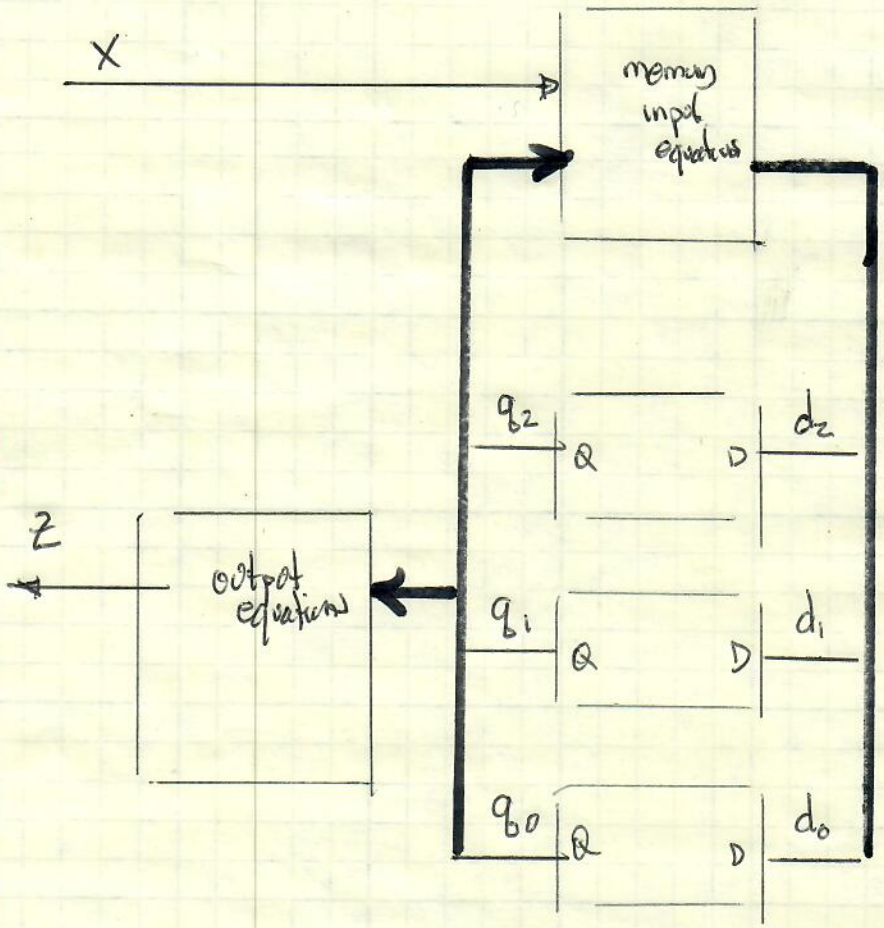



* FSM "looks @ inputs on positive edge"




FSM






$q_0 = 1$ when in state 0

$q_1 = 1$ when in state 1

$q_2 = 1$ when in state 2

| $q_2$ | $q_1$ | $q_0$ | X | $d_2$ | $d_1$ | $d_0$ |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 |

$d_0 = q_2 \cdot X + q_0 X'$

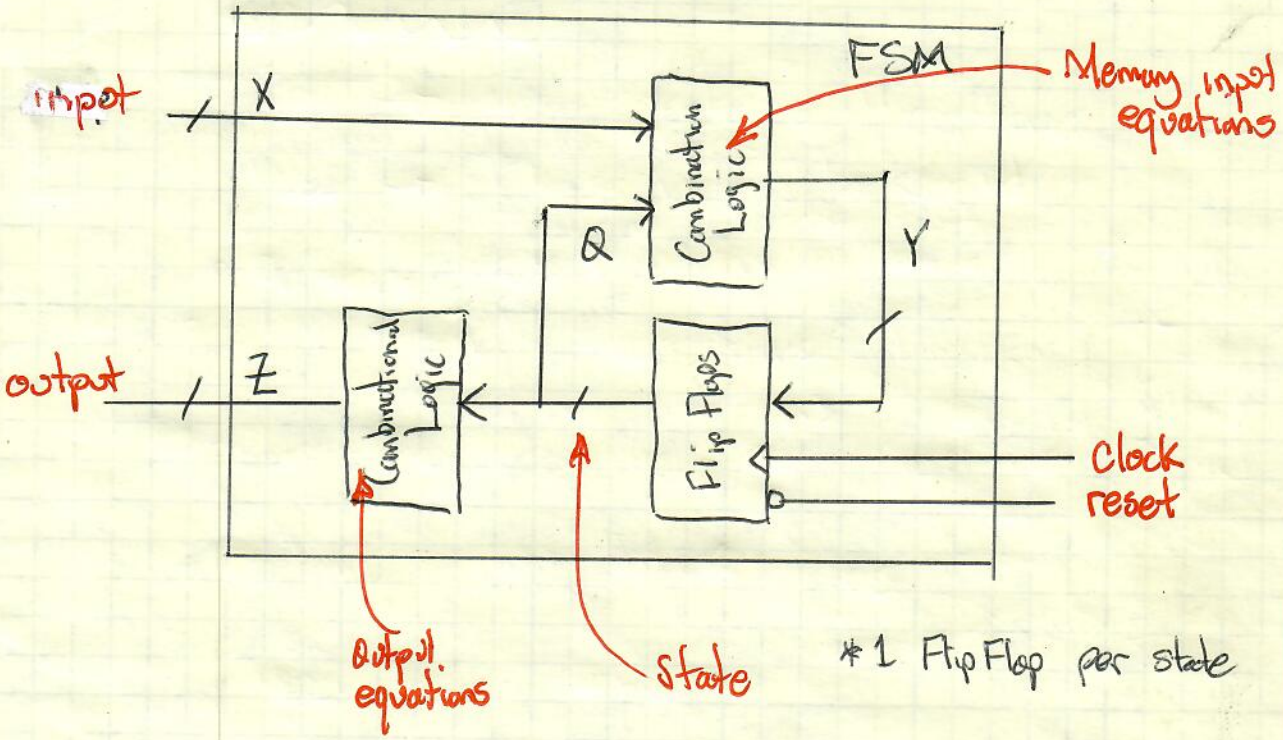
$d_1 = q_1 X' + q_0 X$

$d_2 = q_2 X' + q_1 X$

$Z = q_0$

# Ch 7 Finite State Machines

Circuits whoes output = f(input, state)




## Design Process