Lecture 15, Oct 13, 2022

Clock Dividers (Prescalers)

- How do we generate a different clock frequency from what's given?

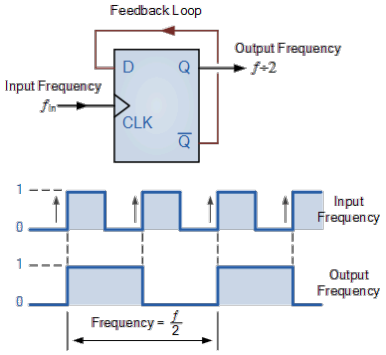

Figure 1: Clock division by 2

- Example: Given a 100MHz clock, derive a circuit using D-flip flops to generate 50MHz and 25MHz clocks
  - The 50MHz clock can be made by tying the input clock into the clock of a T-flip flop
  - The 25MHz clock can be made by putting the 50MHz clock into the clock of a T-flip flop
  - This method is restricted to clock divisions by powers of two
- More generally we can use a counter in order to divide by any factor
  - A NOR gate over all the counter bits can be used as a comparator to check for 0
  - The comparator output can be ANDed together with some signal so the signal only passes through when the counter reaches the desired value

Finite State Machines (FSM)

- Any sequential circuit can be modelled by some set of inputs w_i →combinational circuit A →set of flip flops →combinational circuit B →output
- A finite state machine is so named because a circuit with k registers (flip flops) can only be in one of a finite number of states (2^k states)

Example FSM

- Motor outputs its status on w
- If status is ok, the FSM should maintain $z = 0$
- If motor outputs a sequence of $1, 0, 1$ then an error is occurred, so the FSM should output $z = 1$
- z is determined by the history of w
- First we need a state diagram:
- From this state diagram we can make a state table:

State	Next $w = 0$	Next $w = 1$	z
A	A	B	0
B	C	B	0
C	A	D	0
D	C	B	1

- Now we need to assign states
  - There are 4 states, so we need 2 flip-flops y_2, y_1

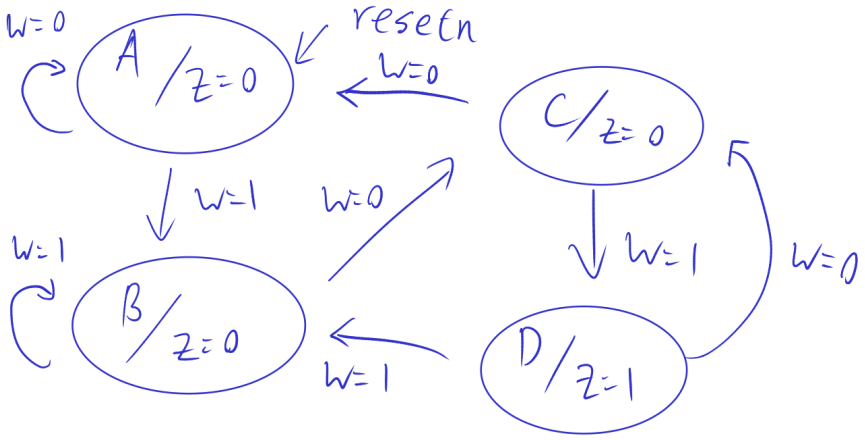

Figure 2: State diagram for the example problem

  - Choose state codes: $A = 00, B = 01, C = 10, D = 11$
- Now make the state-assigned table:

y_2y_1	Y_2Y_1 for $w = 0$	Y_2Y_1 for $w = 1$	z
00	00	01	0
01	10	01	0
10	00	11	0
11	10	01	1

- Now we basically have a truth table, we can synthesize the circuit:
  - $Y_1 = w$
  - $Y_2 = \bar{w}y_1 + wy_2\bar{y}_1$ (can be found through a 3-variable K-map with w, y_1, y_2)
  - $z = y_2y_1$