

**ECE 327/627**

**Digital Hardware Systems**

**Tutorial 4**

## Q1

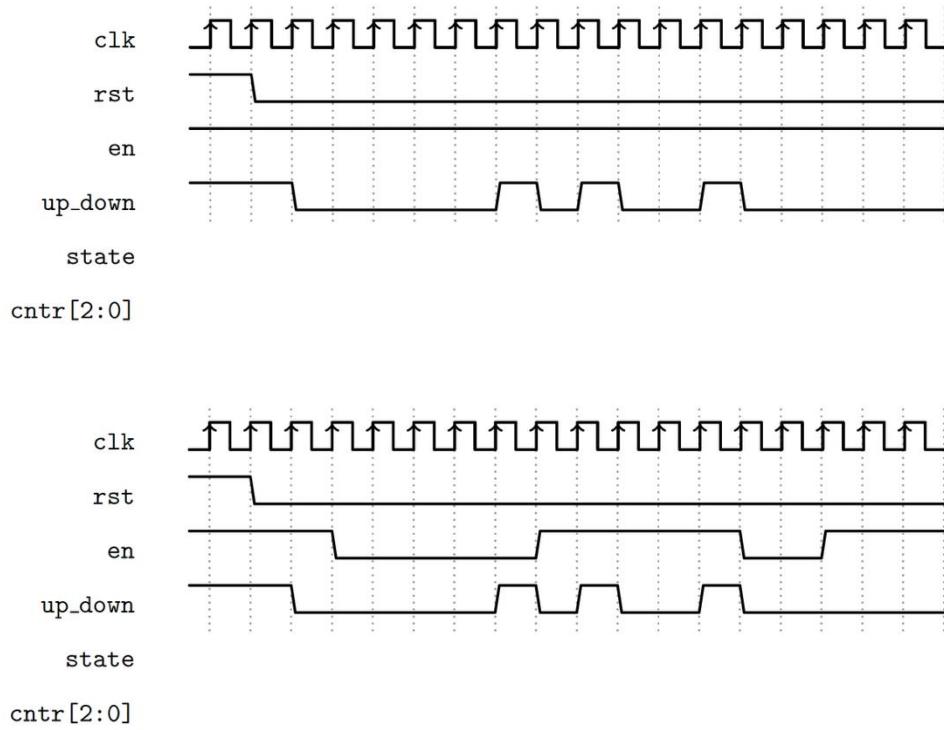
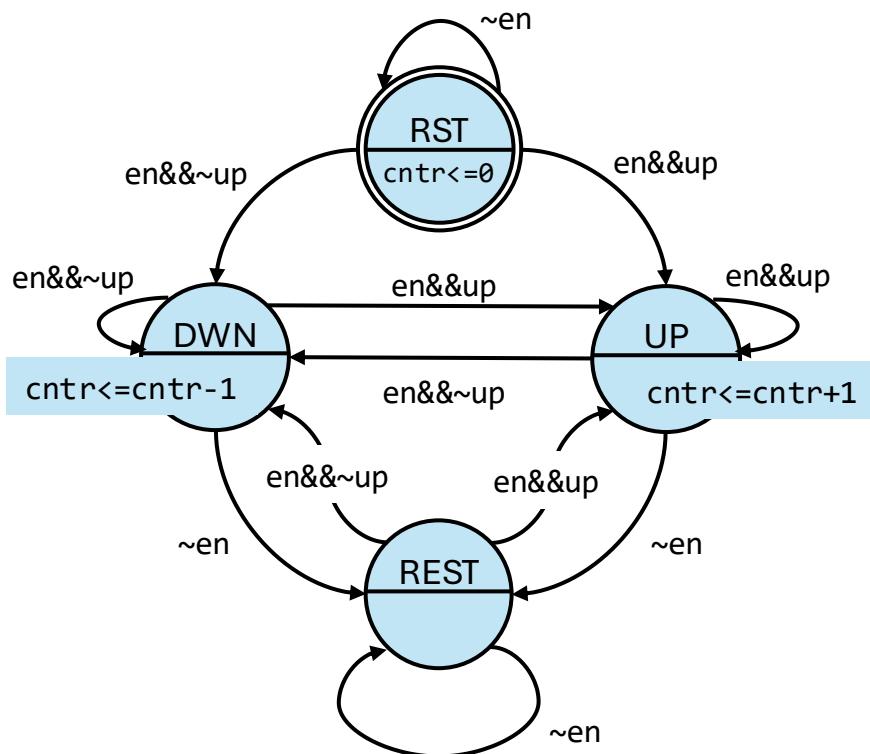
Design a single FSM to detect both the patterns given below. The input arrives one bit at a time (*i\_bit*) from left to right. There are two 1-bit outputs (pa, pb) to indicate which of the two patterns were detected. Output goes high for one cycle after the pattern has been matched. Assume sliding window matching.

- Pattern A: 010110
- Pattern B: 010001

## Q2

Given the following FSM for a 3-bit up/down counter

- Write the SystemVerilog code for it.
- Complete state and cntr traces for the 2 waveforms below



## Q3

In many cases, large messages are sent from one device to another serially as a sequence of bytes (8-bit chunks). You are asked to design a finite-state machine (FSM) that receives a byte-serial message according to a pre-defined protocol and writes it to a memory buffer on the receiver side. The transmitter sends the message in the following format:

[START] [LEN] [ADDR\_H] [ADDR\_L] [DATA\_0] ... [DATA\_n] [CHECKSUM]

- START: Special code 0xAB indicates the beginning of a new message.
- LEN: The number of data bytes in the message.
- ADDR\_H: The higher significance byte of a 16-bit address where the first data byte of the message will be stored.
- ADDR\_L: The lower significance byte of a 16-bit address where the first data byte of the message will be stored.
- DATA\_0, ..., DATA\_n: Data bytes of the message.
- CHECKSUM: The expected result of XORing all data bytes (this will not be stored in memory).

## Q3

The FSM has the following interface:

- input [7:0] byte: Received byte
- input invalid: A flag indicating that the input byte is valid
- output [7:0] wdata: Data to write to the receiver memory
- output [15:0] waddr: Address at which wdata will be written
- output wen: Enable signal for writing to the receiver memory
- output ovalid: A flag indicating that a complete message is written to memory
- output error\_flag: A flag indicating whether the written message has a checksum error or not. It is set to 1'b1 if the result of XORing all the received bytes does not match the CHECKSUM value (i.e., the last byte of the message)