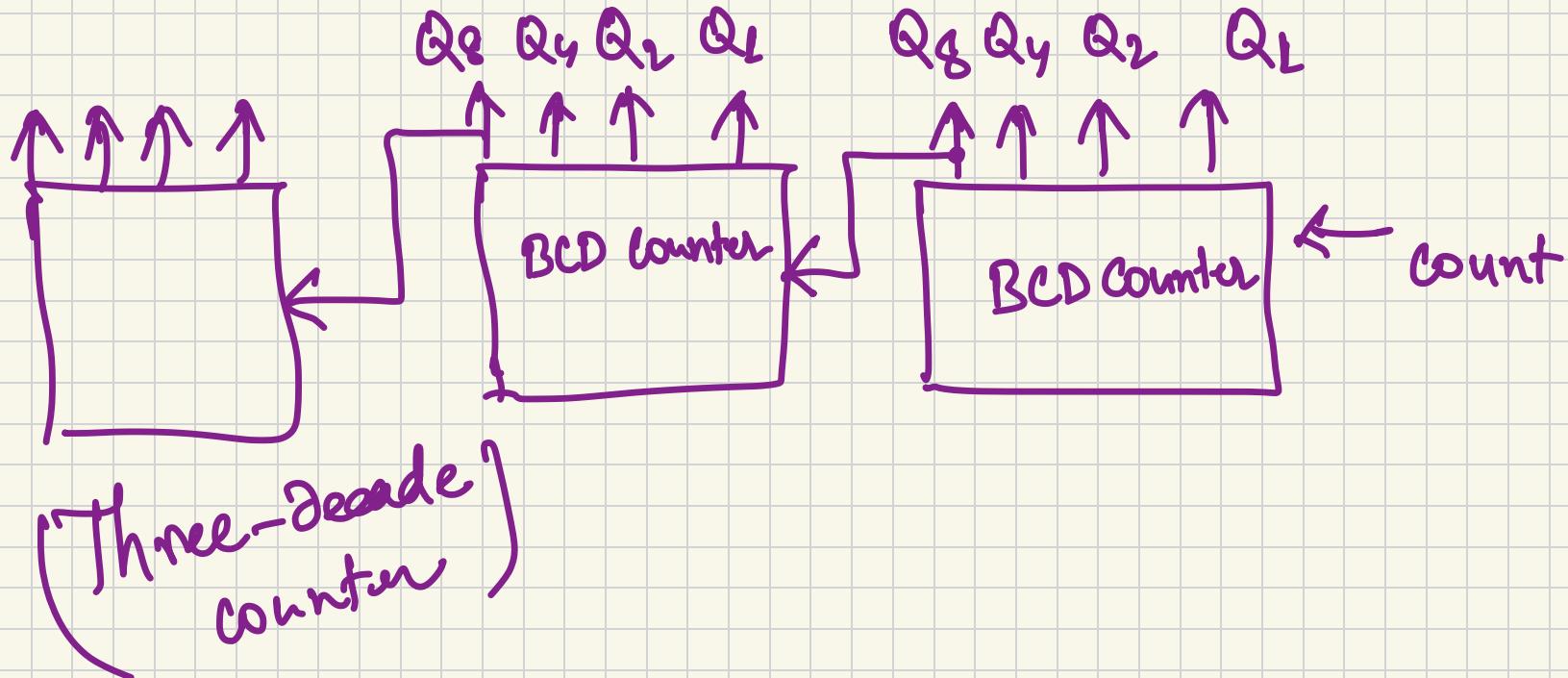


ACOL 215

Two decade counter (19th Nov.)

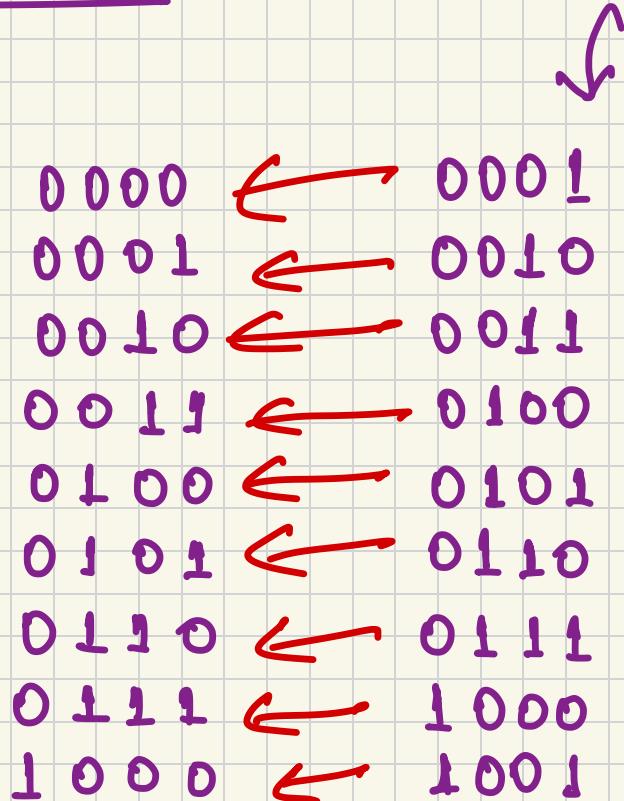


# Synchronous Counters

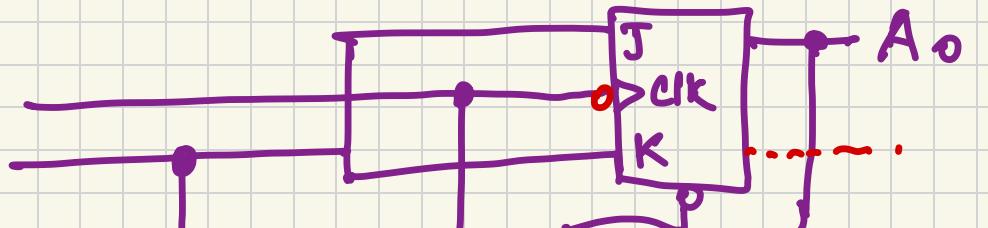
## Binary counter

→ The flip in the least significant position is complemented with every pulse.

→ A flip-flop in any other position is complemented when all the lower bits are L.



Clock  
Count



clear



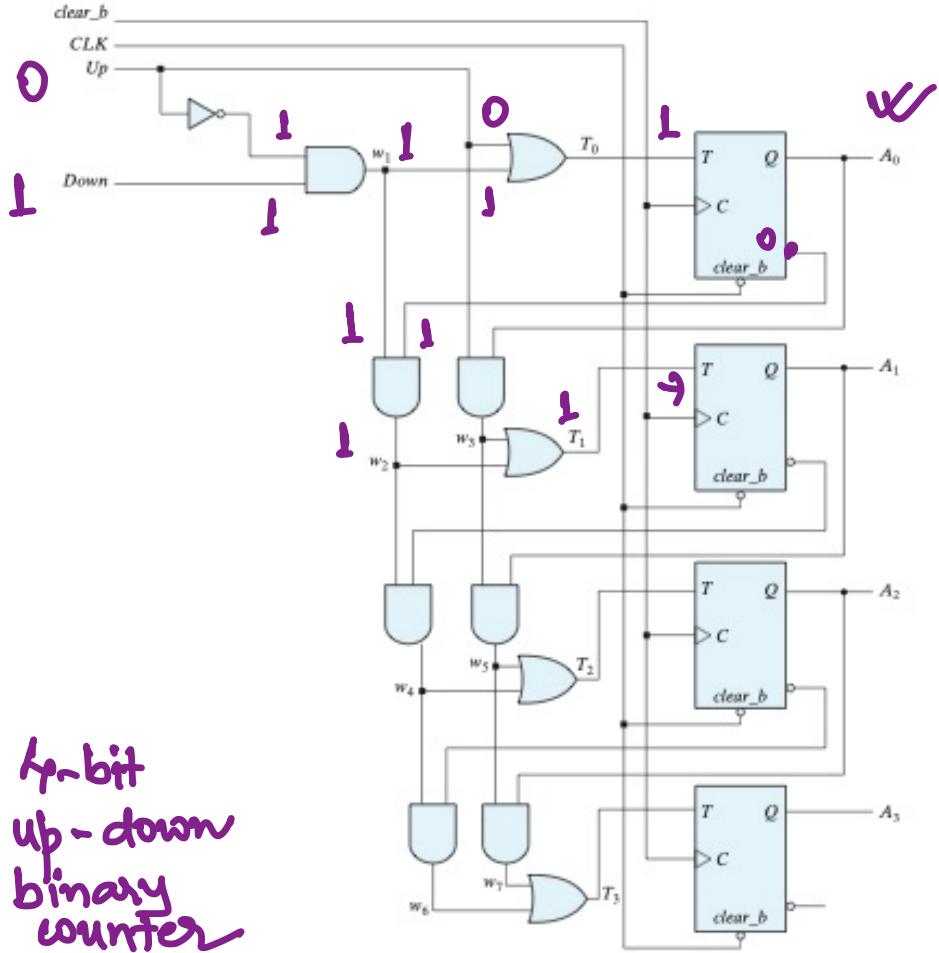
and  
so  
on..

up 1 down X  
 → counts up

up 0 down 1  
 → counts down

up 0 down 0  
 → no change

4-bit  
 up-down  
 binary  
 counter



Synchronous

BCD Counter

Present State

$Q_8 \ Q_4 \ Q_2 \ Q_1$

$0 \ 0 \ 0 \ 0$

$0 \ 0 \ 0 \ 1$

$0 \ 0 \ 1 \ 0$

$0 \ 0 \ 1 \ 1$

$0 \ 1 \ 0 \ 0$

$0 \ 1 \ 0 \ 1$

$0 \ 1 \ 1 \ 0$

$0 \ 1 \ 1 \ 1$

$1 \ 0 \ 0 \ 0$

$1 \ 0 \ 0 \ 1$

Next State

$Q_8 \ Q_4 \ Q_2 \ Q_1$

$0 \ 0 \ 0 \ 1$

$0 \ 0 \ 1 \ 0$

$0 \ 0 \ 1 \ 1$

$0 \ 1 \ 0 \ 0$

$0 \ 1 \ 0 \ 1$

$0 \ 1 \ 1 \ 0$

$0 \ 1 \ 1 \ 1$

$1 \ 0 \ 0 \ 0$

$1 \ 0 \ 0 \ 1$

Output

$y$

$0$

$0$

$0$

$0$

$0$

$0$

$0$

$0$

$0$

$1$

flip-flop inputs

$T_{Q_8} \ T_{Q_4} \ T_{Q_2} \ T_{Q_1}$

$0 \ 0 \mid 0 \ 1$

$0 \ 0 \mid 1 \ 1$

$0 \ 0 \mid 0 \ 1$

$0 \ 1 \mid 1 \ 1$

$0 \ 0 \mid 0 \ 1$

$0 \ 0 \mid 1 \ 1$

$0 \ 0 \mid 0 \ 1$

$0 \ 1 \mid 1 \ 1$

$1 \ 0 \mid 0 \ 1$

$0 \ 0 \mid 1 \ 1$

$$T_{Q_1} = 1$$

$$T_{Q_4} = Q_2 Q_1$$

$$T_{Q_2} = \overline{Q_8' Q_1}$$

$$y = \overline{Q_8 Q_1}$$

Q<sub>2</sub> Q<sub>1</sub>

Q<sub>8</sub> Q<sub>4</sub>

00	01	11	10	
00	0	0	1	0
01	0	0	1	0
11	X	X	X	X
10	0	0	X	X

T<sub>Q<sub>8</sub></sub>

Exercise (draw the logic diagram)

			$Q_1$	
		$Q_2 Q_1$		
	$Q_2 Q_4$		01	11
$T_{Q_2}$		00	1	0
	$Q_8 Q_4$	00	1	0
	$Q_8'$	01	1	0
	$Q_8$	11	X	X
		10	X	X

