

EECS 281, March 19, 2015

## Characteristic Equations

S	R	$Q^*$
0	0	Last $Q$
0	1	0
1	0	1
1	1	0

next state

$$Q^* = ?$$

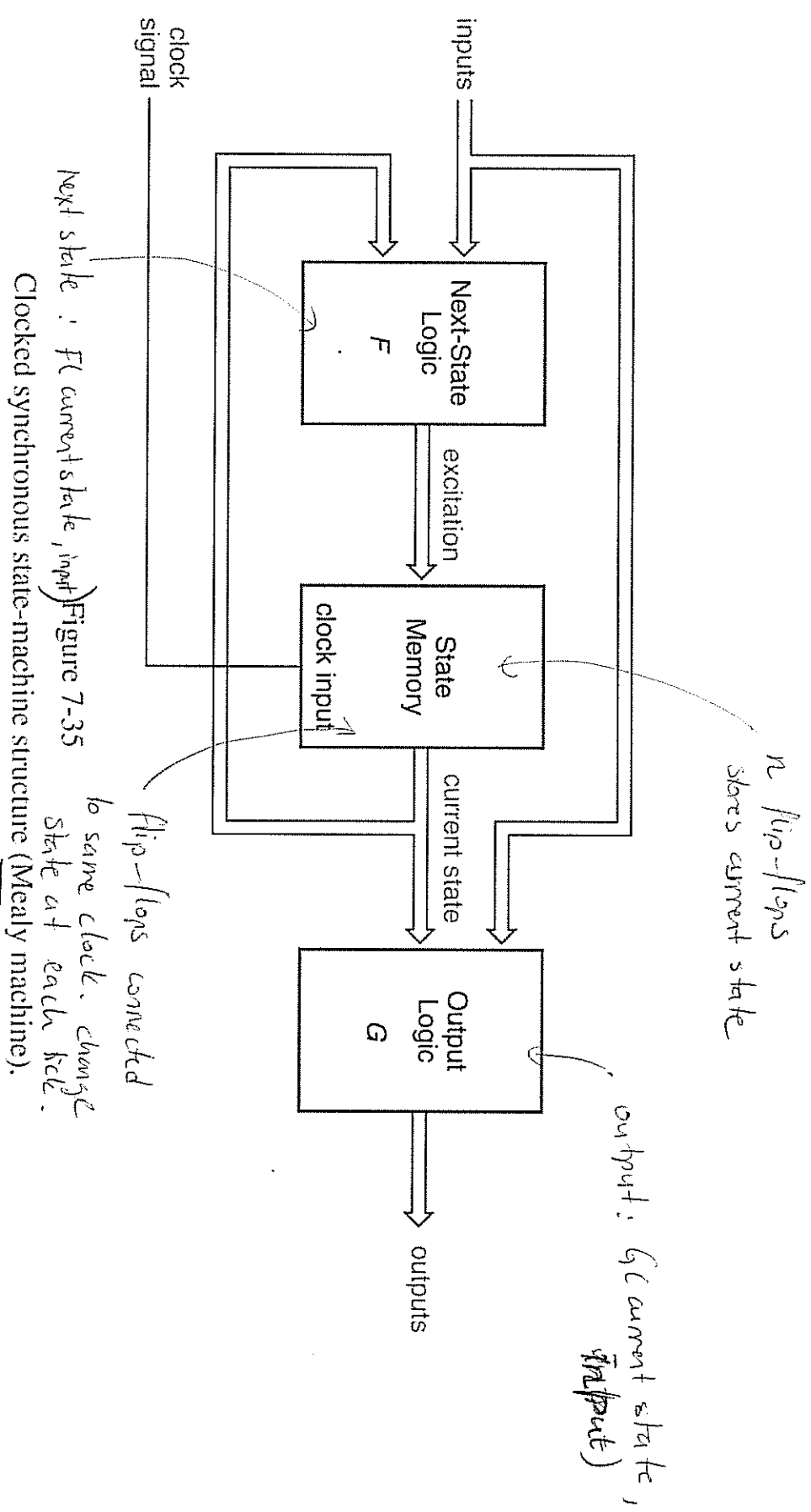
K-map for  $Q^*$ :

$Q \backslash SR$	00	01	11	10
0	0	0	0	1
1	1	0	0	1

$$Q^* = R'Q + \underbrace{SR'}_S = S + R'Q$$

Normal operation:  $SR = 0$

Moore machine: output =  $G$  (current state)



next state:  $F$  (current state, input) Figure 7-35  
Clocked synchronous state-machine structure (Mealy machine).



for Fig 7.38 :

Excitation equations:

$$D0 = Q0 \cdot EN' + Q0' \cdot EN$$

$$D1 = \dots$$

Transition equations

$$Q0^* = D0$$

$$Q1^* = D1$$

Output equation:

$$MAX = Q0 \cdot Q1 \cdot EN$$

Transition, state, state/output Tables:

Transition Table:

		EN	
		0	1
Q1	Q0		
0	0	00	01
0	1	01	10
1	0	10	11
1	1	11	00

$Q1^* \quad Q0^*$   
 $Q1^*$

$$Q0^* = Q0 \cdot EN' + Q0' \cdot EN$$

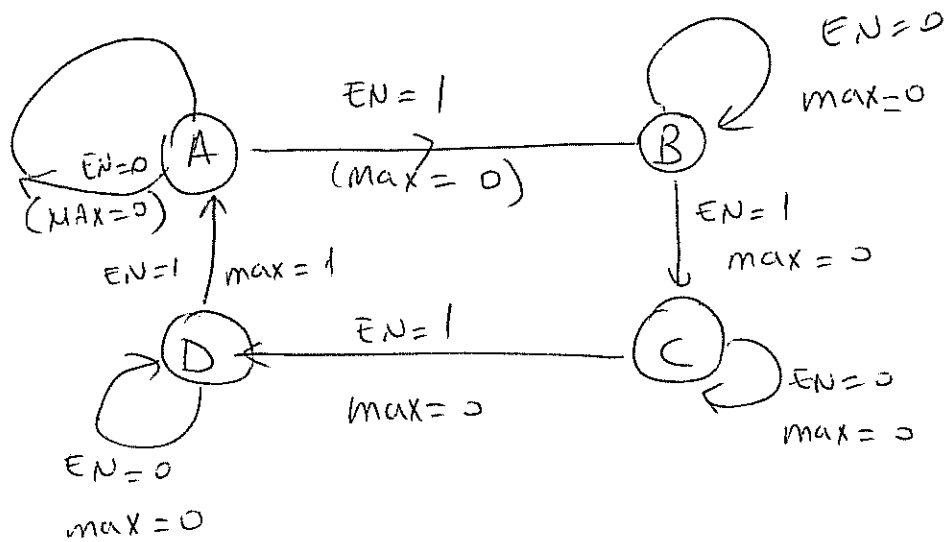
$$Q1^* = Q1 \cdot EN' + Q1' \cdot Q0 \cdot EN + Q1 \cdot Q0' \cdot EN$$

00: A , 01: B , 10: C , 11: D  
 State / output Table:

current state	EN	
S	0	1
A	A, 0	B, 1
B	B, 0	C, 0
C	C, 0	D, 0
D	D, 0	A, 1

next state      output      S\*, MAX

$$MAX = 00.01..EN$$



state table:

$A=00, B=01,$

$C=10, D=11$

alphanumeric  
state  
names

state/output table.

transition table

input

(a)

		EN	
		0	1
states	Q1 Q0	0	1
	00	00	01
	01	01	10
	10	10	11
	11	11	00

2 bit binary counter with enable.

(b)

		EN	
		0	1
S	A	A	B
	B	B	C
	C	C	D
	D	D	A

call:  $q_1q_0=00 \rightarrow \text{name is A}$

(c)

		EN	
		0	1
S	A	A, 0	B, 0
	B	B, 0	C, 0
	C	C, 0	D, 0
	D	D, 0	A, 1

S\* = MAX state.

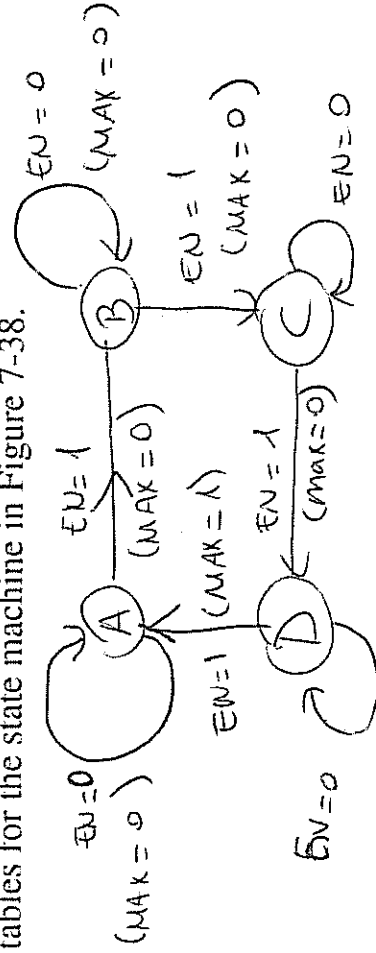
Table 7-2

Transition, state, and state/output tables for the state machine in Figure 7-38.

when  $EN=0$

maintain current count.

when  $EN=1$ , advance by 1 at each tick.



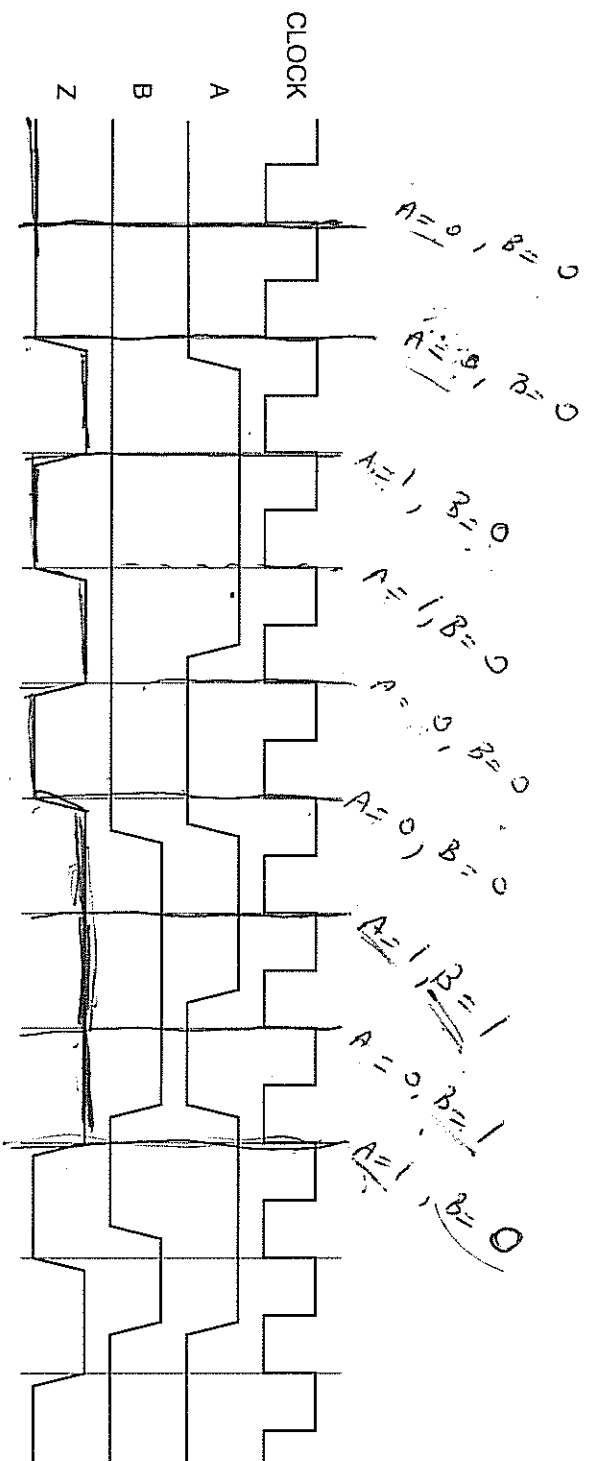


Figure 7-45  
Timing diagram for example state machine.

Example: Design a clocked synchronous state machine with two inputs A and B and a single output Z:

Z becomes 1 when:

- A had the same value at each of the two previous clock ticks or
- B has been 1 since the last time that the first condition was true.

o/w  $Z = 0$ .

Got A=0 on previous tick  
A ≠ 0 on the tick before that

Meaning	State	A B				Z
		00	01	11	10	
Init state	INIT	A0	A0	A1	A1	0
Got a 0 on A	A0	OK0	OK0	A1	A1	0
Got a 1 on A	A1	A0	A0	OK1	OK1	0
	OK0	OK0	OK0	OK1	A1	1
	OK1	A0	OK0	OK1	OK1	1