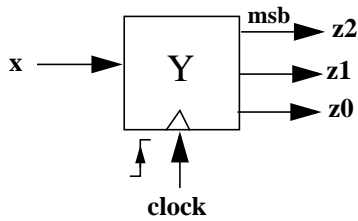


SEQUENTIAL CIRCUIT ANALYSIS

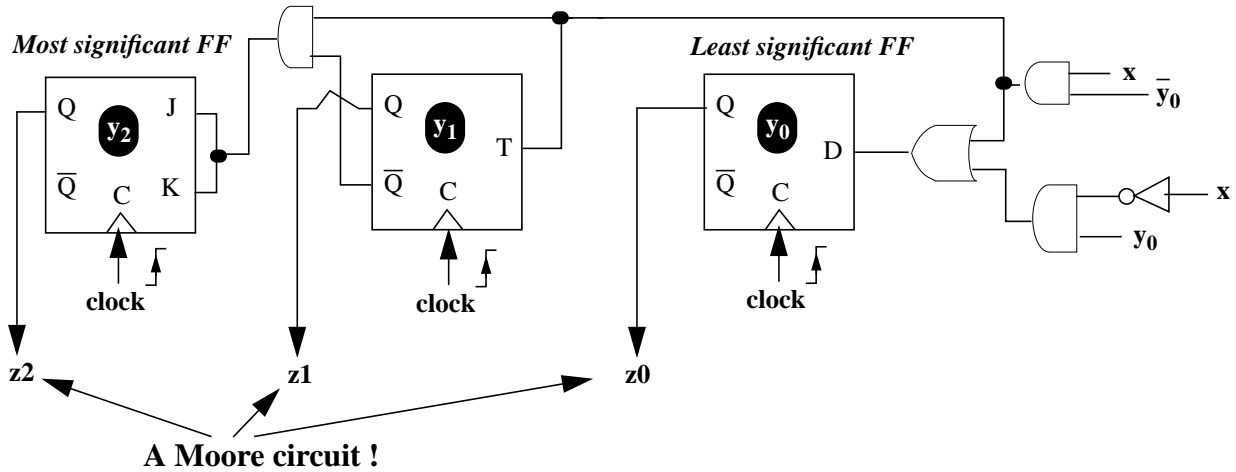
Example I

The sequential circuit :

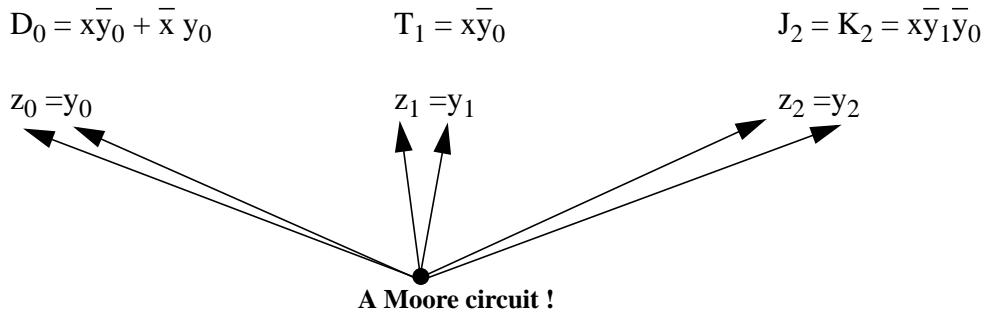


What is the **purpose** of this sequential circuit ?

What does it **do** ?



a) Flip-flop input and sequential circuit output equations :



It is a **Moore** circuit since the sequential circuit outputs are independent of the sequential circuit input. This is seen by observing the sequential circuit output equations which do **not** have the sequential circuit input “x” and also by observing that the sequential circuit output circuits do not have “x” connected to them.

b) Next flip-flip output (next state) equations :

$$\vec{y}_0 = D_0 = x\bar{y}_0 + \bar{x}y_0$$



$$\begin{aligned} \vec{y}_1 &= T_1\bar{y}_1 + \bar{T}_1y_1 = (x\bar{y}_0)\bar{y}_1 + (\overline{x\bar{y}_0})y_1 \\ &= x\bar{y}_1\bar{y}_0 + (\bar{x} + \bar{\bar{y}}_0)y_1 \\ &= x\bar{y}_1\bar{y}_0 + \bar{x}y_1 + y_1y_0 \end{aligned}$$



$$\begin{aligned} \vec{y}_2 &= J_2\bar{y}_2 + \bar{K}_2y_2 = (x\bar{y}_1\bar{y}_0)\bar{y}_2 + (\overline{x\bar{y}_1\bar{y}_0})y_2 \\ &= x\bar{y}_2\bar{y}_1\bar{y}_0 + [\bar{x} + \bar{\bar{y}}_1 + \bar{\bar{y}}_0]y_2 \\ &= x\bar{y}_2\bar{y}_1\bar{y}_0 + \bar{x}y_2 + y_2y_1 + y_2y_0 \end{aligned}$$

c) The excitation table :

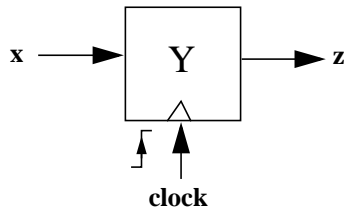
$y_2y_1y_0$	\vec{y}_2	\vec{y}_1	\vec{y}_0	$z_2 z_1 z_0$	
	$x=0$	$x=1$	$x=1$	$x=0$	$x=1$
000	000	111		000	000
001	001	000		001	001
010	010	001		010	010
011	011	010		011	011
100	100	011		100	100
101	101	100		101	101
110	110	101		110	110
111	111	110		111	111

d) The State table :

PS	NS		OUT	
	$x=0$	$x=1$	$x=0$	$x=1$
q ₀	q ₀	q ₇	0	0
q ₁	q ₁	q ₀	1	1
q ₂	q ₂	q ₁	2	2
q ₃	q ₃	q ₂	3	3
q ₄	q ₄	q ₃	4	4
q ₅	q ₅	q ₄	5	5
q ₆	q ₆	q ₅	6	6
q ₇	q ₇	q ₆	7	7

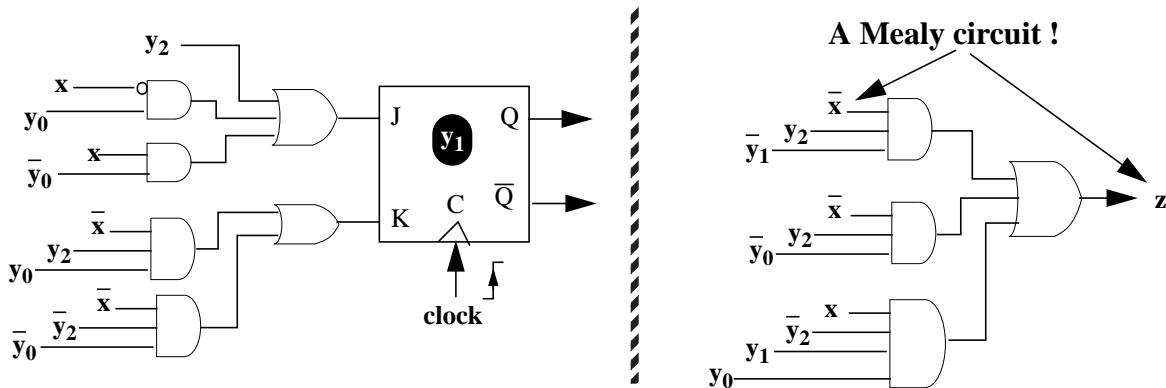
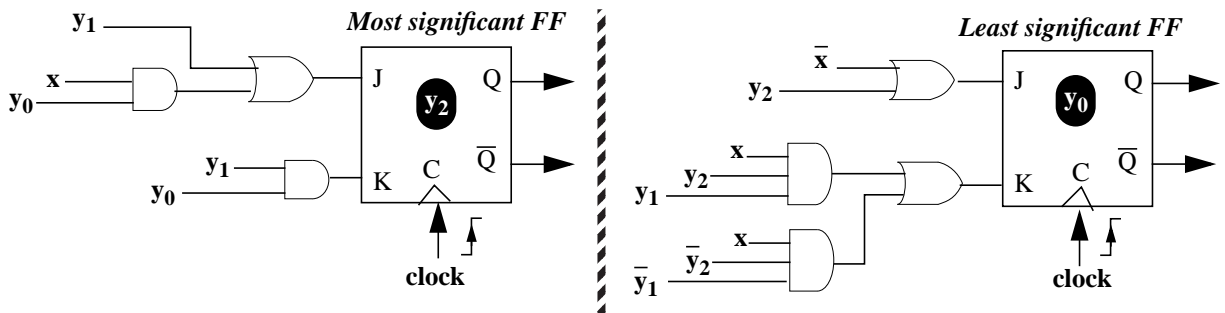
Example II

The sequential circuit :



What is the **purpose** of this sequential circuit ?

What does it **do** ?



a) Flip-flop input and sequential circuit output equations :

$$J_0 = \bar{x} + y_2$$

$$J_1 = y_2 + \bar{x}y_0 + x\bar{y}_0$$

$$J_2 = y_1 + xy_0$$

$$K_0 = xy_2y_1 + x\bar{y}_2\bar{y}_1$$

$$K_1 = \bar{x}y_2y_0 + \bar{x}\bar{y}_2\bar{y}_0$$

$$K_2 = y_1y_0$$

A Mealy circuit !

$$z = xy_2\bar{y}_1 + \bar{x}y_2\bar{y}_0 + x\bar{y}_2y_1y_0$$

It is a **Mealy** circuit since the sequential circuit outputs are dependent on the sequential circuit input “x.” This is seen by observing the sequential circuit output equation which has the sequential circuit input “x” and also by observing that the sequential circuit output circuit has “x” connected to it.

b) Next flip-flip output (next state) equations :

$$\begin{aligned}
 \rightarrow y_0 &= J_0 \bar{y}_0 + \bar{K}_0 y_0 = (\bar{x} + y_2) \bar{y}_0 + \overline{(xy_2 y_1 + x \bar{y}_2 \bar{y}_1)} y_0 \\
 &= \bar{x} \bar{y}_0 + y_2 \bar{y}_0 + [(\overline{xy_2 y_1}) (\overline{x \bar{y}_2 \bar{y}_1})] y_0 \\
 &= \bar{x} \bar{y}_0 + y_2 \bar{y}_0 + [(\bar{x} + \bar{y}_2 + \bar{y}_1) (\bar{x} + y_2 + y_1)] y_0 \\
 &\quad \dots \dots \\
 &= \bar{x} \bar{y}_0 + y_2 \bar{y}_0 + [\bar{x} + \bar{y}_2 y_1 + y_2 \bar{y}_1] y_0 \\
 &\quad \dots \dots \\
 &= \bar{x} + y_2 \bar{y}_0 + \bar{y}_2 y_1 y_0 + y_2 \bar{y}_1
 \end{aligned}$$



$$\begin{aligned}
 \rightarrow y_1 &= J_1 \bar{y}_1 + \bar{K}_1 y_1 = (y_2 + \bar{x} y_0 + x \bar{y}_0) \bar{y}_1 + \overline{(x y_2 y_0 + \bar{x} \bar{y}_2 \bar{y}_0)} y_1 \\
 &= y_2 \bar{y}_1 + \bar{x} \bar{y}_1 y_0 + x \bar{y}_1 \bar{y}_0 + [(\overline{x y_2 y_0}) (\overline{\bar{x} \bar{y}_2 \bar{y}_0})] y_1 \\
 &= y_2 \bar{y}_1 + \bar{x} \bar{y}_1 y_0 + x \bar{y}_1 \bar{y}_0 + [(x + \bar{y}_2 + \bar{y}_0) (x + y_2 + y_0)] y_1 \\
 &\quad \dots \dots \\
 &= y_2 \bar{y}_1 + \bar{x} \bar{y}_1 y_0 + x \bar{y}_1 \bar{y}_0 + [x + \bar{y}_2 y_0 + y_2 \bar{y}_0] y_1 \\
 &\quad \dots \dots \\
 &= y_2 \bar{y}_1 + x \bar{y}_0 + x y_1 + y_2 \bar{y}_0 + \bar{x} \bar{y}_2 y_0
 \end{aligned}$$



$$\begin{aligned}
 \rightarrow y_2 &= J_2 \bar{y}_2 + \bar{K}_2 y_2 = (y_1 + x y_0) \bar{y}_2 + \overline{(y_1 y_0)} y_2 \\
 &= \bar{y}_2 y_1 + x \bar{y}_2 y_0 + [\bar{y}_1 + \bar{y}_0] y_2 \\
 &= \bar{y}_2 y_1 + x \bar{y}_2 y_0 + y_2 \bar{y}_1 + y_2 \bar{y}_0
 \end{aligned}$$

c) The excitation table :

$y_2 y_1 y_0$	$\rightarrow y_2$	$\rightarrow y_1$	$\rightarrow y_0$	z	
	$x=0$	$x=1$	$x=1$	$x=0$	$x=1$
0 0 0	0 0 1	0 1 0		0	0
0 0 1	0 1 1	1 0 0		0	0
0 1 0	1 0 1	1 1 0		0	0
0 1 1	1 1 1	1 1 1		0	1
1 0 0	1 1 1	1 1 1		1	0
1 0 1	1 1 1	1 1 1		1	0
1 1 0	1 1 1	1 1 1		1	0
1 1 1	0 0 1	0 1 0		0	0