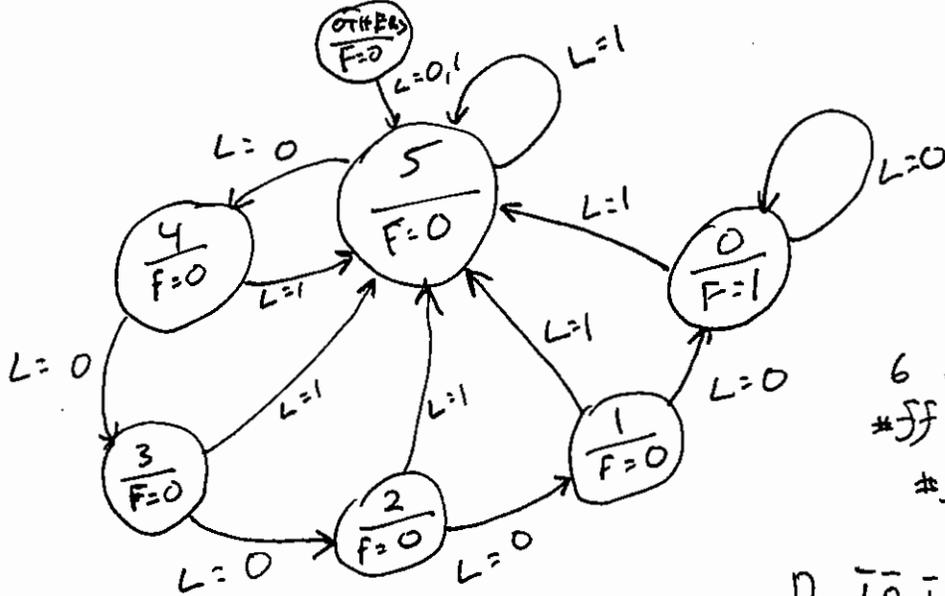


EE313 – Extra Synchronous Design Problem
Rev 03/19/2012

1) Design a circuit that counts from 5 to 0 when an Active Low Launch button L is pressed. When the counter reaches 0, A missile should be fired by sending an Active High signal F to the missile. The counter should reset to 5 and stay at 5 if the launch button is released at any time. Once the counter has reached 0, it should stay at 0 as long as the Launch button is being pressed.



6 states \Rightarrow
 $\#FF \geq \log_2(6) \approx 2.5$
 $\#FlipFlops = 3$

L	Q_2^n	Q_1^n	Q_0^n	D_2 Q_2^{n+1}	D_1 Q_1^{n+1}	D_0 Q_0^{n+1}	F
0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0
0	0	1	0	0	0	1	0
0	0	1	1	0	1	0	0
0	1	0	0	0	1	1	0
0	1	0	1	1	0	0	0
0	1	1	0	1	0	1	0
0	1	1	1	1	0	0	0
1	0	0	0	1	0	1	1
1	0	0	1	1	0	1	0
1	0	1	0	1	0	1	0
1	0	1	1	1	0	1	0
1	1	0	0	1	0	1	0
1	1	0	1	1	0	1	0
1	1	1	0	1	0	1	0
1	1	1	1	1	0	1	0

$F = \bar{Q}_2 \bar{Q}_1 \bar{Q}_0$

D_2 $\bar{L}\bar{Q}_2$ $\bar{L}Q_2$ LQ_2 $L\bar{Q}_2$

\bar{Q}_1, \bar{Q}_0	0	0	1	1
\bar{Q}_1, Q_0	0	1	1	1
Q_1, Q_0	0	1	0	1
Q_1, \bar{Q}_0	0	1	1	1

$D_2 = L + Q_0 Q_2 + Q_1 Q_2$

D_1 $\bar{L}\bar{Q}_2$ $\bar{L}Q_2$ LQ_2 $L\bar{Q}_2$

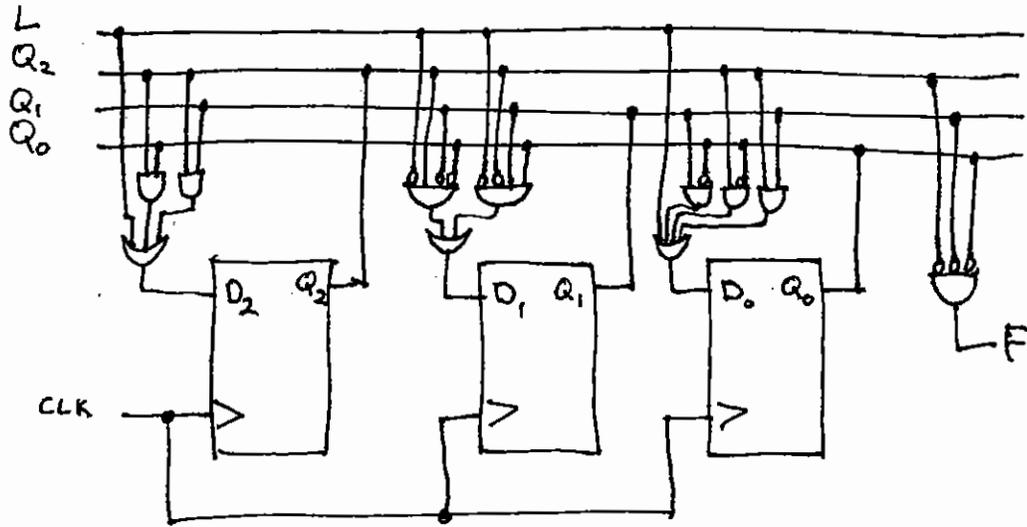
\bar{Q}_1, \bar{Q}_0	0	1	0	0
\bar{Q}_1, Q_0	0	0	0	0
Q_1, Q_0	1	0	0	0
Q_1, \bar{Q}_0	0	0	0	0

$D_1 = \bar{L}Q_2 \bar{Q}_1 \bar{Q}_0 + \bar{L}Q_2 Q_1 Q_0$

D_0 $\bar{L}\bar{Q}_2$ $\bar{L}Q_2$ LQ_2 $L\bar{Q}_2$

\bar{Q}_1, \bar{Q}_0	0	1	1	1
\bar{Q}_1, Q_0	0	0	1	1
Q_1, Q_0	0	1	1	1
Q_1, \bar{Q}_0	1	1	1	1

$D_0 = L + Q_1 \bar{Q}_0 + Q_2 \bar{Q}_0 + Q_2 Q_1$



2) Design a circuit that Multiplies two 2 bit numbers A and B when clocked and outputs the result to output Y.

A ₁ A ₀		B ₁ B ₀		A × B	D ₃	D ₂	D ₁	D ₀
				Y ₃ Y ₂ Y ₁ Y ₀				
0 0	0	0 0	0	0	0	0	0	0
0 0	0	0 1	1	0	0	0	0	0
0 0	0	1 2	0	0	0	0	0	0
0 0	0	1 3	1	0	0	0	0	0
0 1	1	0 0	0	0	0	0	0	0
0 1	1	0 1	1	1	0	0	0	1
0 1	1	1 2	0	2	0	0	1	0
0 1	1	1 3	1	3	0	0	1	1
1 2	0	0 0	0	0	0	0	0	0
1 2	0	0 1	1	2	0	0	1	0
1 2	0	1 2	0	4	0	1	0	0
1 2	0	1 3	1	6	0	1	1	0
1 3	1	0 0	0	0	0	0	0	0
1 3	1	0 1	1	3	0	0	1	1
1 3	1	1 2	0	6	0	1	1	0
1 3	1	1 3	1	9	1	0	0	1

9 Values ⇒ Y = Y₃ Y₂ Y₁ Y₀

$$D_1 = A_1 \bar{B}_1 B_0 + A_1 B_1 \bar{B}_0 + A_1 B_1 B_0$$

D₁

	A ₀ A ₀	A ₁ A ₁	A ₁ A ₀	A ₁ A ₀
B ₁ B ₁	0	0	0	0
B ₁ B ₀	0	0	1	1
B ₀ B ₁	0	1	0	1
B ₀ B ₀	0	1	1	0

D₂

	A ₁ A ₀			
B ₁ B ₁	0	0	0	0
B ₁ B ₀	0	0	0	0
B ₀ B ₁	0	0	0	1
B ₀ B ₀	0	0	1	1

D₂ = B₁ B₀ A₁ + B₁ A₁ A₀

	A ₁ A ₀			
B ₁ B ₁	0	0	0	0
B ₁ B ₀	0	1	0	1
B ₀ B ₁	0	1	0	1
B ₀ B ₀	0	0	0	0

$$D_0 = \bar{A}_1 A_0 B_0 + A_1 \bar{A}_0 B_0$$

OTHER METHODS EXIST.

