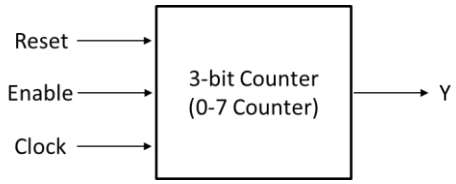
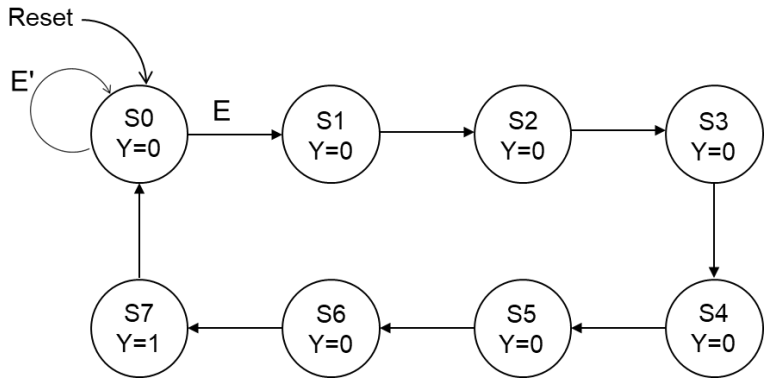
State Machine Design Class Exercise

Develop the circuit for a three-bit counter. Upon reset, the counter starts at 000. There is an enable input (E). When E is 1 (HIGH), the counter starts counting at each clock edge. When the counter reaches 111, it sets an output (Y) to HIGH. For all other counts, the output stays LOW. After it reaches 000 again, it checks enable input, E. If E is 1, it continues to count; if E is 0 (LOW) it stays at 000. Use a Moore Machine to develop the circuit.

System Functional Block Diagram:



1) Develop the state transition diagram that shows state identifiers, input variables, and outputs. Mark the state to enter upon reset. Determine the number of state variables.



8 states => 3 state variables

2) Develop the state transition table with state variables and inputs.

Present State, S	*Present State* q_2	q_1	q_0	Input, *E*	Next State, S^+	*Next State* q_2^+	q_1^+	q_0^+
S0	0	0	0	0	S0	0	0	0
S0	0	0	0	1	S1	0	0	1
S1	0	0	1	X	S2	0	1	0
S2	0	1	0	X	S3	0	1	1
S3	0	1	1	X	S4	1	0	0
S4	1	0	0	X	S5	1	0	1
S5	1	0	1	X	S6	1	1	0
S6	1	1	0	X	S7	1	1	1
S7	1	1	1	X	S0	0	0	0

3) Develop the equations for next state variables (i.e. state register inputs)

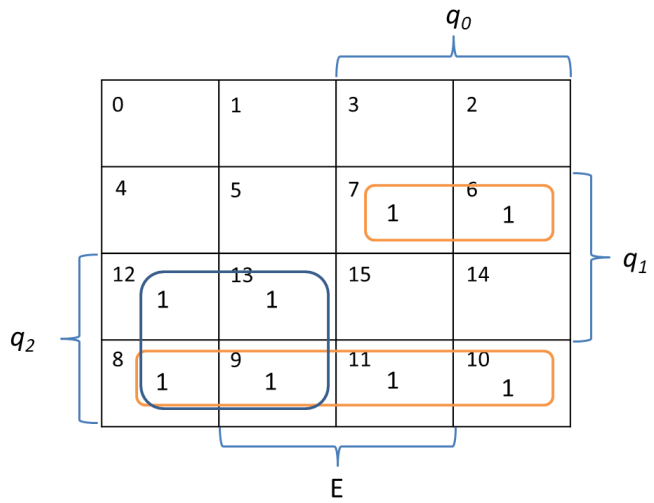
$q_2^+ = q_2' q_1 q_0 + q_2 q_1' q_0' + q_2 q_1' q_0 + q_2 q_1 q_0'$

$q_1^+ = q_2' q_1' q_0 + q_2' q_1 q_0' + q_2 q_1' q_0 + q_2 q_1 q_0'$

$q_0^+ = q_2' q_1' q_0' E + q_2' q_1 q_0' + q_2 q_1' q_0' + q_2 q_1 q_0'$

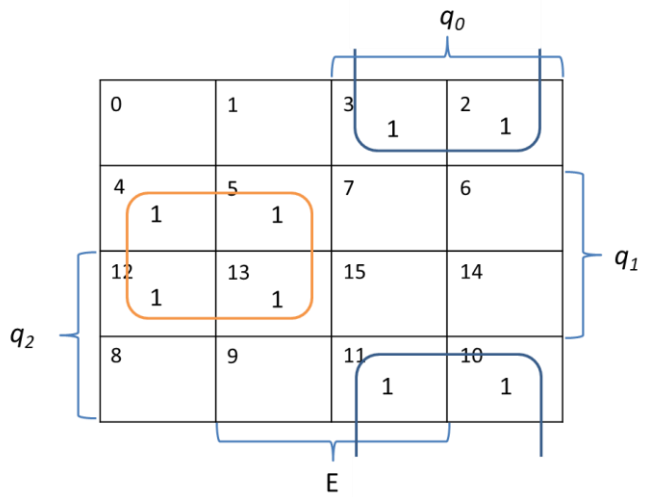
Simplify the equations using K-maps:

$q_2^+(q_2, q_1, q_0, E)$



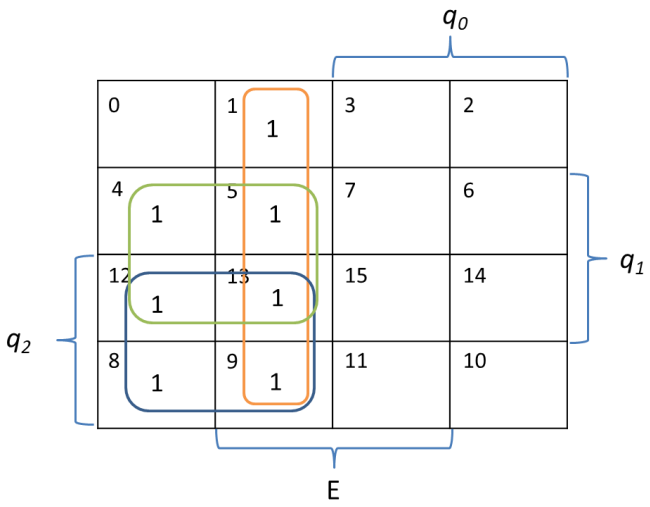
$q_2^+ = q_2' q_1 q_0 + q_2 q_1' + q_2 q_0'$

$q_1^+(q_2, q_1, q_0, E)$



$q_1^+ = q_1' q_0 + q_1 q_0'$

$q_0^+(q_2, q_1, q_0, E)$



$q_0^+ = q_0' E + q_1 q_0' + q_2 q_0'$

4) Develop the output table:

Present State, S	*Present State* q_2	q_1	q_0	Output, *Y*
S0	0	0	0	0
S1	0	0	1	0
S2	0	1	0	0
S3	0	1	1	0
S4	1	0	0	0
S5	1	0	1	0
S6	1	1	0	0
S7	1	1	1	1

5) Develop the output equation:

Y = $q_2 q_1 q_0$

6) Draw the next state and output circuits: