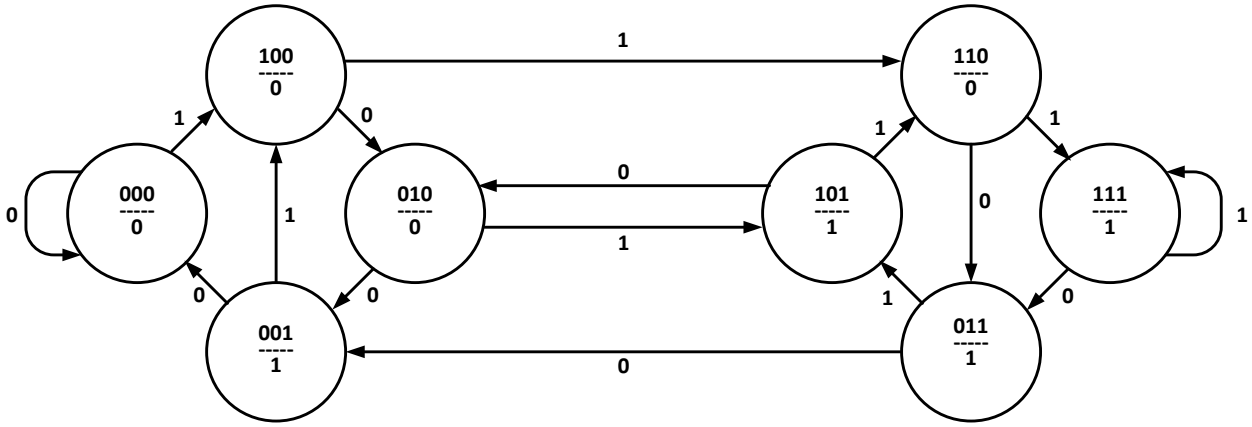
Hardware & Architecture HW #7 – 200 Points

1. A sequential circuit has a single-bit input, A, and a single bot output Z. Z=1 each time the sequence 010 occurs, but otherwise Z=0. Assume a Mealy-Type Finite State Machine
   - **a.** (10 Pts) Construct a State Transition Diagram. Show input, output, and transition conditions appropriately.
   - **b.** (10 Pts) Construct the State Transition Table.
   - **c.** (10 Pts) Use Karnaugh Maps to derive the characteristic next state equations
   - **d.** (10 Pts) Use a Karnaugh Map to derive the output equation.

2. (40 Pts) Repeat all parts of the previous problem for a Moore-Type Finite State Machine.

3. The Easter Bunny is automating the egg coloring process using an assembly line for applying base color, highlight color, and glitter. The Assembly line contains 0 to 3 eggs at any given time. Depending on how efficiently the Easter Bunny can input the eggs into the system. Based on the State Transition Diagram for the Easter egg coloring assembly line is shown below (1 ⇒ Egg, 0 ⇒ No Egg).



   - **a.** (20 Pts) Create a State Transition Table based on the State Transition Diagram.
   - **b.** (3 Pts) Is this a Mealy Machine or a Moore Machine? Explain your answer.

4. Design a 4-bit counter with one input (Start), four negative-edge triggered J-K flip-flops, and basic gates that will count down the 12 Days of Christmas from 12 to 1. Once the count is at 1, it should remain in that state unless the input "Start" is received (pulse) that will asynchronously restart the counter to 12 for the next countdown (Hint: Use the asynchronous Preset and/or Clear input to reset the latches when the Start input is received).
   - **a.** (16 Pts) Create the State Transition Table (Without the Asynchronous restart functionality)
   - **b.** (16 Pts) Determine the simplest expression (use Karnaugh Maps) for the J and K inputs of each J-K Flip-Flop. SHOW YOUR WORK.

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5. A Leprechaun will grant you a wish if you are lucky, but if you are unlucky, a Leprechaun will steal your gold. The keys to obtaining luck are knowledge of the Rainbow's End location and/or possession of a 4–Leaf Clover. The transitions between the states of Lucky and Unlucky are governed by the following rules:

- If you are in a Lucky State, you will stay in the Lucky State if you have knowledge of the Rainbow's End location AND/OR if you possess a 4–Leaf Clover.
- If you are in the Lucky State you will transition to the Unlucky state if you lose track of the Rainbow's End location AND you misplace your 4–Leaf Clover.
- If you are in an Unlucky State, you will remain in the Unlucky State until you find the location of the Rainbow's End AND acquire a 4–Leaf Clover.

The outputs of the states are Wish Granted or Gold Stolen depending on whether you are Lucky or Unlucky.

Let the synchronous Input Signals

- RE = 1 ⇒ Rainbow's End Location known
- 4LC = 1 ⇒ Possession of 4–Leaf Clover

RE = 0 ⇒ Rainbow's End Location not known

4LC = 0 ⇒ No Possession of 4–Leaf Clover

Let the synchronous Output Signals

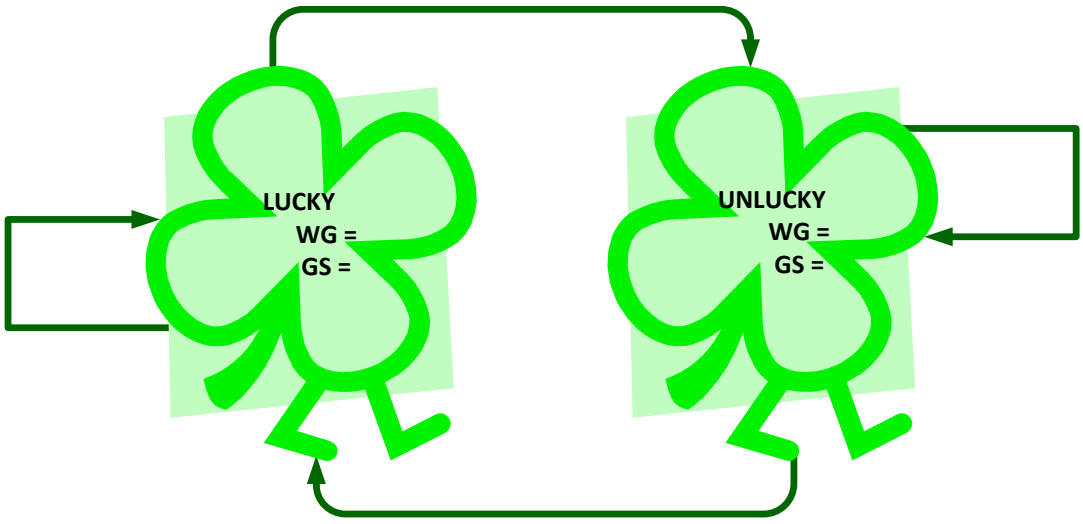
- WG = 1 ⇒ Wish Granted.
- GS = 1 ⇒ Gold Stolen

WG = 0 ⇒ No Wish Granted

GS = 0 ⇒ No Gold Stolen

There are also asynchronous LUCK OF THE IRISH and CURSE OF THE IRISH signals that will put you in the Lucky or Unlucky state, respectively.

a. (9 Pts) Complete the given State Transition Diagram.



b. (3 Pts) Thinking of the Latch as a Finite State Machine, would you classify it as a Mealy type, a Moore type, or a combination of the two. Explain your answer

c. (24 Pts – 4 Pts Per Column) Complete the given State Transition Table

Current State	Next State	Inputs		Outputs	
Q	**Q_{Next}**	**RE**	**4LC**	**WG**	**GS**

d. (3 Pts) Derive the Characteristic Next State Equation of the Latch (Use a K-map with the Current State Bits and the Inputs)

e. (6 Pts – 3 Pts Each) Derive the Output Equations for WG and GS

6. (20 Pts) Find and describe a real-world application of Finite State Machines. This question will involve research outside of D2L. You may not use an elevator, garage door opener, vending machine, or any other example covered in the text or posted course materials. This should be at least 300 words and include a State Transition Diagram or State Transmission Table.