Prelab

1. **Fill in the remaining entries in Table 1. You may find the discussion on Generating Timing Delays in the background section helpful.**

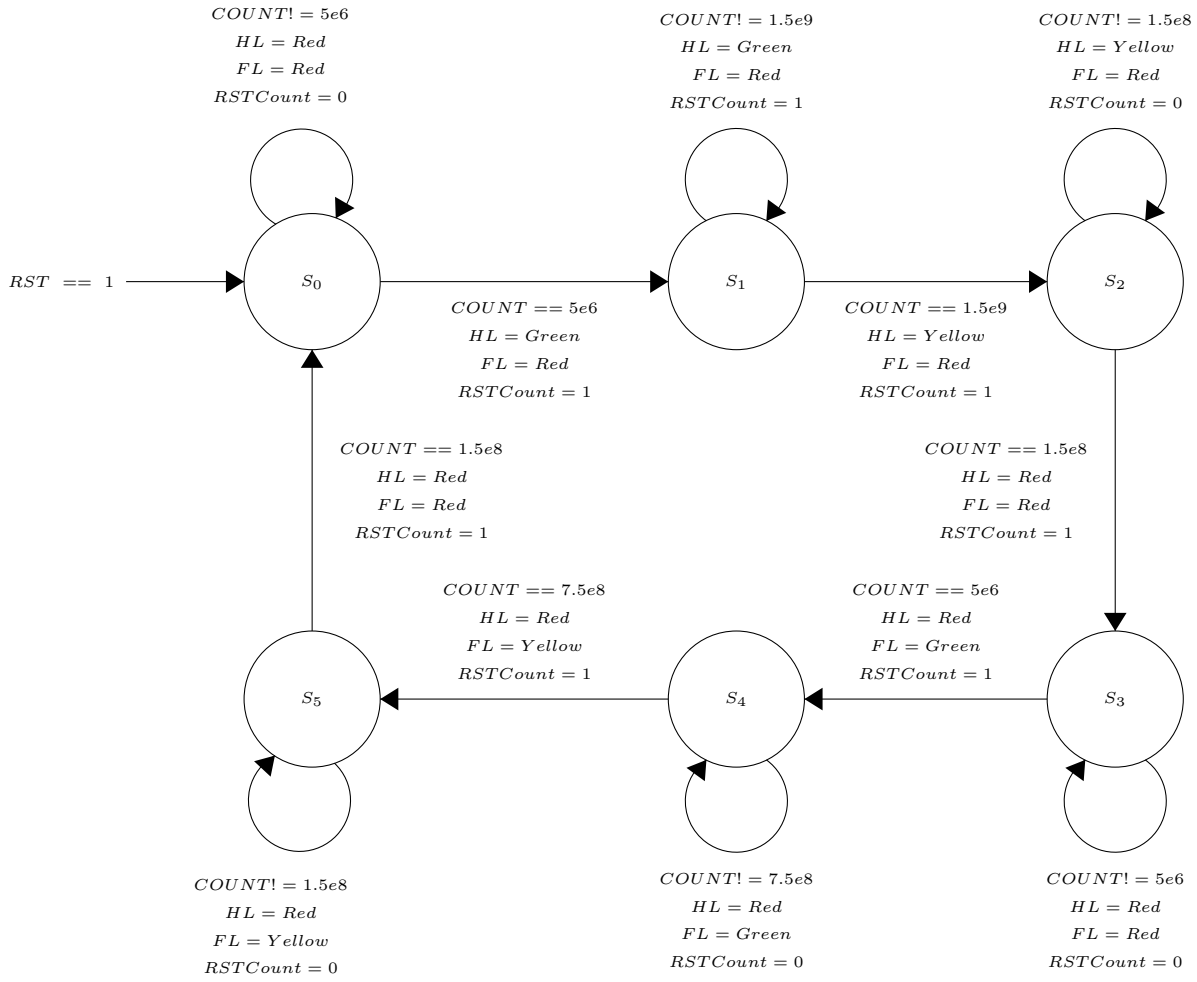
Table 1: Traffic Light Controller States

State	Highway Output	Farm Road Output	Delay (seconds)	Delay (cc)
S0	red	red	1	50,000,000
S1	green	red	30	1,500,000,000
S2	yellow	red	3	150,000,000
S3	red	red	1	50,000,000
S4	red	green	15	750,000,000
S5	red	yellow	3	150,000,000

2. **Based on the column entries you just calculated, what is the necessary value of n in Figure 5?**

   The largest number that will need to be represented in binary is 1,500,000,000. That number in binary is 1011001011010000010111100000000 which consits of 31 bits thus $n = 31$ wires.

3. **Given Table 1 and Figure 6, create a state diagram for the traffic light controller FSM. Be sure to include the appropriate input and output labels. Assume S0 is the reset state.**



4. **Now describe the traffic light controller FSM in Verilog using the following module interface**

Code Block 1: TLC FSM Verilog

```
1  module tlc_fsm (
2          output reg [2:0] state, // output for debugging
3          output reg RstCount, // use an always block
4          // another always block for these as well
5          output reg [1:0] highwaySignal, farmSignal,
6          input wire [31-1:0] Count,
7          input wire Clk, Rst // clokc and reset
8          );
9
10         parameter S0 = 3'b000,
```

```
11                  S1 = 3'b001,
12                  S2 = 3'b010,
13                  S3 = 3'b011,
14                  S4 = 3'b100,
15                  S5 = 3'b101,
16                  GREEN = 2'b00,
17                  YELLOW = 2'b01,
18                  RED = 2'b10;
19
20          reg [2:0] nextState;
21
22          // Output logic
23          always @ (state or RstCount) begin
24                  case (state)
25                          S0: begin
26                          if (RstCount) begin
27                                  highwaySignal = GREEN;
28                                  farmSignal = RED;
29                          end else begin
30                                  highwaySignal = RED;
31                                  farmSignal = RED;
32                          end
33                          end
34                          S1: begin
35                          if (RstCount) begin
36                                  highwaySignal = YELLOW;
37                                  farmSignal = RED;
38                          end else begin
39                                  highwaySignal = GREEN;
40                                  farmSignal = RED;
41                          end
```

```
42                  end
43                  S2: begin
44                  if (RstCount) begin
45                          highwaySignal = RED;
46                          farmSignal = RED;
47                  end else begin
48                          highwaySignal = YELLOW;
49                          farmSignal = RED;
50                  end
51                  end
52                  S3: begin
53                  if (RstCount) begin
54                          highwaySignal = RED;
55                          farmSignal = GREEN;
56                  end else begin
57                          highwaySignal = RED;
58                          farmSignal = RED;
59                  end
60                  end
61                  S4: begin
62                  if (RstCount) begin
63                          highwaySignal = RED;
64                          farmSignal = YELLOW;
65                  end else begin
66                          highwaySignal = RED;
67                          farmSignal = GREEN;
68                  end
69                  end
70                  S5: begin
71                  if (RstCount) begin
72                          highwaySignal = RED;
```

```
73                                  farmSignal = RED;
74                          end else begin
75                                  highwaySignal = GREEN;
76                                  farmSignal = YELLOW;
77                          end
78                          end
79
80                          default: ;
81                  endcase
82          end
83
84
85
86
87          // Next state logic
88          always @ ( * ) begin
89                  case (state)
90                          S0: begin
91                                  if (Count == 50000000) begin
92                                          nextState = S1;
93                                  end else begin
94                                          nextState = S0;
95                                  end
96                                  end
97                          S1: begin
98                                  if (Count == 1500000000) begin
99                                          nextState = S2;
100                                 end else begin
101                                         nextState = S1;
102                                 end
103                                 end
```

```
104                         S2: begin
105                                 if (Count == 150000000) begin
106                                         nextState = S3;
107                                 end else begin
108                                         nextState = S2;
109                                 end
110                                 end
111                         S3: begin
112                                 if (Count == 50000000) begin
113                                         nextState = S4;
114                                 end else begin
115                                         nextState = S3;
116                                 end
117                                 end
118                         S4: begin
119                                 if (Count == 750000000) begin
120                                         nextState = S5;
121                                 end else begin
122                                         nextState = S4;
123                                 end
124                                 end
125                         S5: begin
126                                 if (Count == 150000000) begin
127                                         nextState = S1;
128                                 end else begin
129                                         nextState = S5;
130                                 end
131                                 end
132                         default: ;
133                 endcase
134         end
```

```
135
136         always @ (posedge Clk) begin
137                 if (Rst) begin
138                         stat <= S0;
139                 end else begin
140                         state <= nextState;
141                 end
142         end
143
144         assign Count = 0;
145
146 endmodule // tlc_fsm
```