# Homework 5

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**Part 1**

| $S_n$ | $S_{n+1}$ |
|---|---|
| $S_0$ | $S_1$ |
| $S_1$ | $S_2$ |
| $S_2$ | $S_3$ |
| $S_3$ | $S_4$ |
| $S_4$ | $S_5$ |
| $S_5$ | $S_2$ |
| $S_6$ | $S_7$ |
| $S_7$ | $S_6$ |

8 states means 3 bits.

| $S_n$ | $S_{n+1}$ |
|---|---|
| $S_0$ | 110 |
| $S_1$ | 100 |
| $S_2$ | 000 |
| $S_3$ | 001 |
| $S_4$ | 011 |
| $S_5$ | 010 |
| $S_6$ | 101 |
| $S_7$ | 111 |

| $Q_2^n$ | $Q_1^n$ | $Q_0^n$ | $Q_2^{n+1}$ | $Q_1^{n+1}$ | $Q_0^{n+1}$ |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 0 | 1 |

$D_2 = Q_2(Q_1 + Q_0)$
$D_1 = Q_0(\overline{Q_1} + \overline{Q_2})$
$D_0 = \overline{Q_2}.\overline{Q_1} + Q_2Q_0$

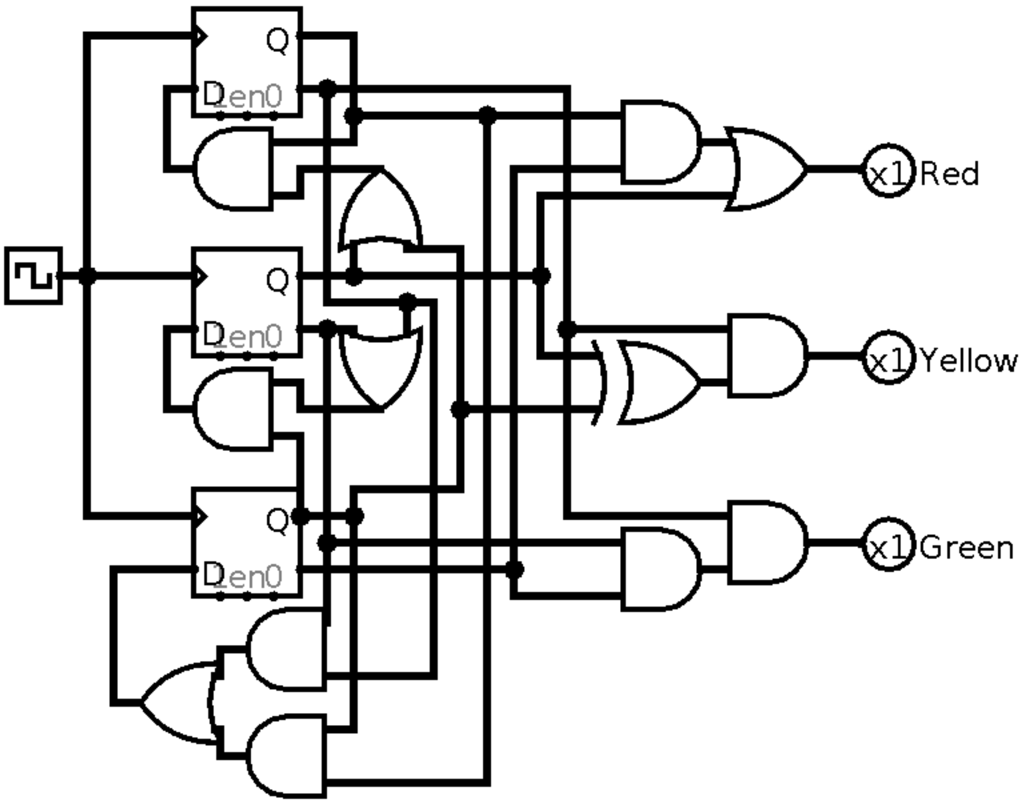
| $Q_2^n$ | $Q_1^n$ | $Q_0^n$ | R | Y | G |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 | 0 |

Python simulation:

```python
Q2 = 1
Q1 = 1
Q0 = 1

def NOT( a ):
    return 1 - a

for step in range( 20 ):

    D2 = Q2 & (Q1 | Q0)
    D1 = Q0 & (NOT(Q2) | NOT(Q1))
    D0 = (NOT(Q2) & NOT(Q1)) | (Q2 & Q0)
    R = (Q2 & NOT(Q0)) | Q1
    Y = NOT(Q2) & (Q1 ^ Q0)
    G = NOT(Q2) & NOT(Q1) & NOT(Q0)

    print( "Q2 Q1 Q0 = %d %d %d | R Y G = %d %d %d" %
     ( Q2, Q1, Q0, R, Y, G ) )
    input( "> " )

    Q0 = D0
    Q1 = D1
    Q2 = D2
```

```
Q2 Q1 Q0 = 1 1 0 | R Y G = 1 0 0
>
Q2 Q1 Q0 = 1 0 0 | R Y G = 1 0 0
>
Q2 Q1 Q0 = 0 0 0 | R Y G = 0 0 1
>
Q2 Q1 Q0 = 0 0 1 | R Y G = 0 1 0
>
Q2 Q1 Q0 = 0 1 1 | R Y G = 1 0 0
>
Q2 Q1 Q0 = 0 1 0 | R Y G = 1 1 0
>
Q2 Q1 Q0 = 0 0 0 | R Y G = 0 0 1
>
Q2 Q1 Q0 = 0 0 1 | R Y G = 0 1 0
>
Q2 Q1 Q0 = 0 1 1 | R Y G = 1 0 0
>
Q2 Q1 Q0 = 0 1 0 | R Y G = 1 1 0
>
```

```
Q2 Q1 Q0 = 1 0 1 | R Y G = 0 0 0
>
Q2 Q1 Q0 = 1 1 1 | R Y G = 1 0 0
>
Q2 Q1 Q0 = 1 0 1 | R Y G = 0 0 0
>
Q2 Q1 Q0 = 1 1 1 | R Y G = 1 0 0
>
Q2 Q1 Q0 = 1 0 1 | R Y G = 0 0 0
>
Q2 Q1 Q0 = 1 1 1 | R Y G = 1 0 0
>
Q2 Q1 Q0 = 1 0 1 | R Y G = 0 0 0
>
```




**Part 2**

There are 4 ways to connect $S_6$ or $S_7$ to another state by changing only one bit: 101 $\rightarrow$ 100, 101 $\rightarrow$ 001, 111 $\rightarrow$ 110, and 111 $\rightarrow$ 011

Of these options, only 101 $\rightarrow$ 001 reduces the number of covers in a Karnaugh map of the affected bits.

$D_2$

| $Q_2$ \ $Q_1Q_0$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |

Becomes:

$D_2$

| $Q_2 \backslash Q_1Q_0$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 |

The result changes the equation for $D_2$ from $D_2 = Q_2(Q_1 + Q_0)$ to $D_2 = Q_2Q_1$. The adjusted circuit diagram is as follows: