3. In this question you will design a simple Finite State Machine (FSM) that implements a 3-bit Gray Code counter. The FSM will not have any inputs and have three output bits G_2, G_1, G_0. Gray codes are specialized codes where consecutive numbers differ in only one bit position as seen in the table below.

State	Gray Code Output		
S	G_2	G_1	G_0
S_0	0	0	0
S_1	0	0	1
S_2	0	1	1
S_3	0	1	0
S_4	1	1	0
S_5	1	1	1
S_6	1	0	1
S_7	1	0	0

The following is a state transition diagram of this FSM with the states named S_0 to S_7.
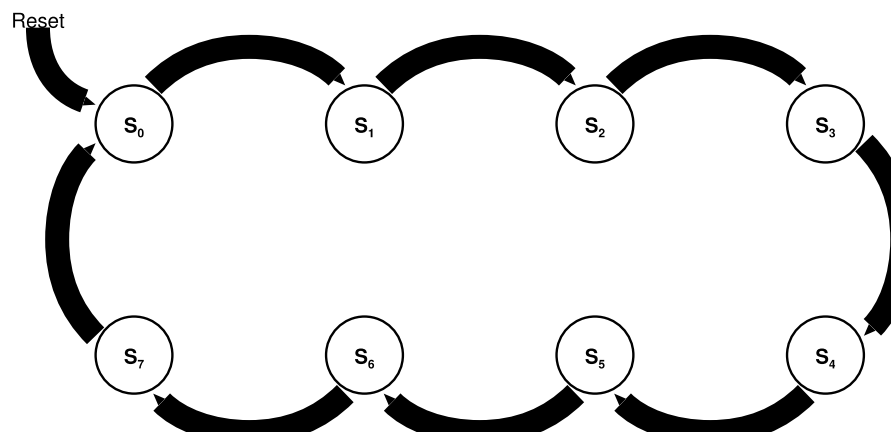
a) Is this a Moore or Mealy type FSM? (1 point)

Moore type, since the output G only depends on the state as there are no inputs

b) It has been decided to use a simple binary state encoding using 3-bits where each state is encoded in standard binary. I.e. $S_0 = 000$, $S_1 = 001$, ... , $S_6 = 110$, $S_7 = 111$. Make a state transition table using the binary state encodings given above. Determine the next state equations. (4 points)

Current State			Next State		
S_2	S_1	S_0	N_2	N_1	N_0
0	0	0	0	0	1
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	1	0	0
1	0	0	1	0	1
1	0	1	1	1	0
1	1	0	1	1	1
1	1	1	0	0	0

N2 = S2'S1S0 + S2S1' + S2S0'
N1 = S1'S0 + S1S0'
N0 = S0'

c) Now determine the output equations that calculate the outputs G2, G1, G0 from the state bits S0, S1, S2. (3 points)

G2 = S2
G1 = S2S1' + S2'S1
G0 = S1'S0 + S1S0'

d) In step b), we have used a binary coding for the states. As a result, we needed a additional circuit to calculate the outputs from the State bits. In this part we will directly use the gray code for the state encoding. In this way, the state will directly be the required gray code, and no additional output encoding will be required.

Make a new state transition table and determine the next state equations using the gray code as state encoding. (5 points)

Current State			Next State		
S_2	S_1	S_0	N_2	N_1	N_0
0	0	0	0	0	1
0	0	1	0	1	1
0	1	0	1	1	0
0	1	1	0	1	0
1	0	0	0	0	0
1	0	1	1	0	0
1	1	0	1	1	1
1	1	1	1	0	1

N2 = S2S0 + S1S0'
N1 = S2'S0 + S1S0'
N2 = S2'S1' + S2S1

e) Which solution would you prefer (using binary coding for the states as in b or gray coding as in d)? Explain with a short sentence. (2 points)

Using the gray code as the state encoding results in a simpler circuit with fewer gates, it would be better to use that one.