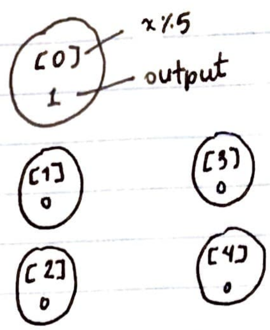
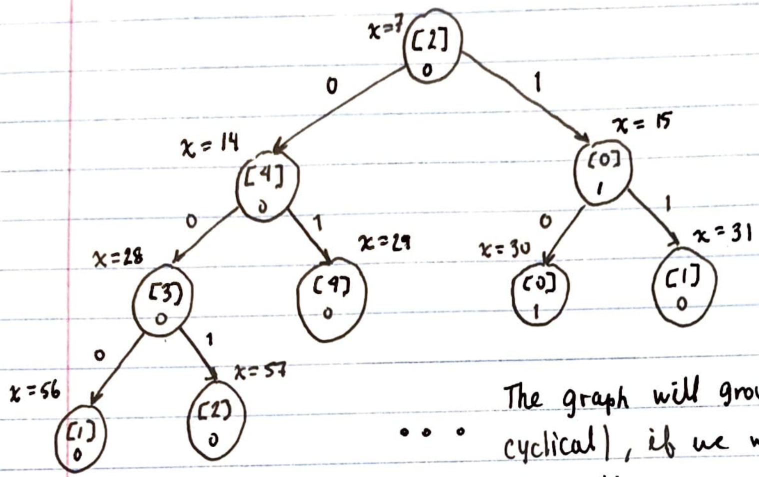
Q2) mod 5 ⇒ 5 states

States :



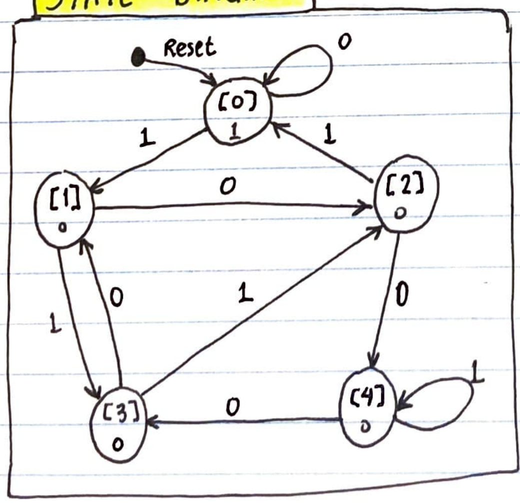
- $x \% 5 = 0$ [0]
- $x \% 5 = 1$ [1]
- $x \% 5 = 2$ [2]
- $x \% 5 = 3$ [3]
- $x \% 5 = 4$ [4]

Test with $x = 7$ to observe the patterns



• • • The graph will grow forever (because it is modular/cyclical), if we write enough terms we can observe the pattern:

STATE DIAGRAM



STATE TRANSITION TABLE (Symbolic)

Present State	Input	Next State	Output
[0]	0	[0]	1
[0]	1	[1]	0
[1]	0	[2]	0
[1]	1	[3]	0
[2]	0	[4]	0
[2]	1	[0]	1
[3]	0	[1]	0
[3]	1	[2]	0
[4]	0	[3]	0
[4]	1	[4]	0

Encoded State Transition Table

	Present State $Q_2 Q_1 Q_0$	Input	Next State $(Q_2 Q_1 Q_0)^+$	Output
[0]	0 0 0	0	0 0 0	1
	0 0 0	1	0 0 1	0
[1]	0 0 1	0	0 1 0	0
	0 0 1	1	0 1 1	0
[2]	0 1 0	0	1 0 0	0
	0 1 0	1	0 0 0	1
[3]	0 1 1	0	0 0 1	0
	0 1 1	1	0 1 0	0
[4]	1 0 0	0	0 1 1	0
	1 0 0	1	1 0 0	0

Make K-maps

1) K-Map for Q_2^+

In \ $Q_2Q_1Q_0$	000	001	010	011	100
0	0	0	1	0	0
1	0	0	0	0	1

1) $\overline{In}\cdot\overline{Q_0} \cdot \overline{In}\cdot Q_1 \cdot \overline{In}\cdot\overline{Q_2} \equiv \boxed{\overline{In}\cdot\overline{Q_0}\cdot Q_1\cdot\overline{Q_2}}$

2) $\boxed{In\cdot\overline{Q_0}\cdot\overline{Q_1}\cdot Q_2}$

$F_2 = \overline{In}\cdot\overline{Q_0}\cdot Q_1\cdot\overline{Q_2} + In\cdot\overline{Q_0}\cdot\overline{Q_1}\cdot Q_2$

2) K-Map for Q_1^+

In \ $Q_2Q_1Q_0$	000	001	010	011	100
0	0	1	0	0	1
1	0	1	0	1	0

1) $\overline{In}\cdot\overline{Q_2}\cdot\overline{Q_1}\cdot Q_0 + \overline{In}\cdot Q_2\cdot\overline{Q_1}\cdot\overline{Q_0}$

2) $In\cdot\overline{Q_2}\cdot\overline{Q_1}\cdot Q_0 + In\cdot\overline{Q_2}\cdot Q_1\cdot Q_2$

$F_1 = \overline{I_n}(\overline{Q_2}\cdot\overline{Q_1}\cdot Q_0 + Q_2\cdot\overline{Q_1}\cdot\overline{Q_0}) + In(\overline{Q_2}\cdot\overline{Q_1}\cdot Q_0 + \overline{Q_2}\cdot Q_1\cdot Q_2)$

3) K-map for Q_0^+

In \ $Q_2Q_1Q_0$	000	001	010	011	100
0	0	0	0	1	1
1	1	1	0	0	0

1) $\overline{In} \cdot \overline{Q_2} \cdot Q_1 \cdot Q_0 + \overline{In} \cdot Q_2 \cdot \overline{Q_1} \cdot \overline{Q_0} = \overline{In} \cdot (\overline{Q_2} \cdot Q_1 \cdot Q_0 + Q_2 \cdot \overline{Q_1} \cdot \overline{Q_0})$

2) $In \cdot \overline{Q_2} \cdot \overline{Q_1} \cdot \overline{Q_0} + In \cdot Q_2 \cdot \overline{Q_1} \cdot \overline{Q_0} = In \cdot (\overline{Q_2} \cdot \overline{Q_1} \cdot \overline{Q_0} + \overline{Q_2} \cdot \overline{Q_1} \cdot Q_0)$

$F_0 = \overline{In}(\overline{Q_2} \cdot Q_1 \cdot Q_0 + Q_2 \cdot \overline{Q_1} \cdot \overline{Q_0}) + In(\overline{Q_2} \cdot \overline{Q_1} \cdot \overline{Q_0} + \overline{Q_2} \cdot \overline{Q_1} \cdot \overline{Q_0})$

Now that we have our 3 functions
we can make our circuit

$F_{Q_0^+} = \overline{In}(\overline{Q_2} \cdot Q_1 \cdot Q_0 + Q_2 \cdot \overline{Q_1} \cdot \overline{Q_0}) + In(\overline{Q_2} \cdot \overline{Q_1} \cdot \overline{Q_0} + \overline{Q_2} \cdot \overline{Q_1} \cdot Q_0)$ ✓

$F_{Q_1^+} = \overline{In}(\overline{Q_2} \cdot \overline{Q_1} \cdot Q_0 + Q_2 \cdot \overline{Q_2} \cdot \overline{Q_0}) + In(\overline{Q_2} \cdot \overline{Q_1} \cdot Q_0 + \overline{Q_2} \cdot Q_1 \cdot Q_0)$ ✓

$F_{Q_2^+} = \overline{In}(\overline{Q_2} \cdot Q_1 \cdot \overline{Q_0}) + In(Q_2 \cdot \overline{Q_1} \cdot \overline{Q_0})$ ✓

5 states means we need 3 flip flops $(2^3 = 6)$

Find my circuit inside file Q2.circ inside my assignment folder

:)