HOMEWORK 5

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1. Analyze the synchronous sequential circuit given in the figure below by answering following questions.

- Determine the input functions of the flip-flops.

Input Functions Of J-K Flip Flop:

J = $\overline{X}Q_1$

K = $\overline{X \oplus Q_1}$ = $(\overline{X}Q_1 + X\overline{Q_1})$ = $(\overline{X} + Q_1)(X + \overline{Q_1})$ = $\overline{Q_1}\,\overline{X} + XQ_1$

Input Functions of D Flip Flop:

D = X

- Determine the next states (use Q0 for JK-FF, and Q1 for D-FF) and output expression.

$Q_0^+ = J\overline{Q_0} + \overline{K}Q_0$ ⟹ $Q_0^+ = \overline{X}Q_1\overline{Q_0} + \overline{\overline{\overline{X}Q_1 + X\overline{Q_1}}}Q_0$

$Q_0^+ = \overline{X}Q_1\overline{Q_0} + (\overline{X}Q_1 + X\overline{Q_1})Q_0 = \overline{X}Q_1\overline{Q_0} + \overline{X}Q_1Q_0 + X\overline{Q_1}Q_0$

$Q_0^+ = \overline{X}Q_1\overline{Q_0} + \overline{X}Q_1Q_0 + X\overline{Q_1}Q_0 = \overline{X}Q_1(\overline{Q_0}+Q_0) + X\overline{Q_1}Q_0$ (Inverse)

$Q_0^+ = \overline{X}Q_1 + X\overline{Q_1}Q_0$ (Next State of J-K flip flop)

Q_1^+ = D ⟹ Q_1^+ = X (Next State of D flip flop)

Z = XQ_0Q_1 (Output Expression)

- Derive the state/output table.

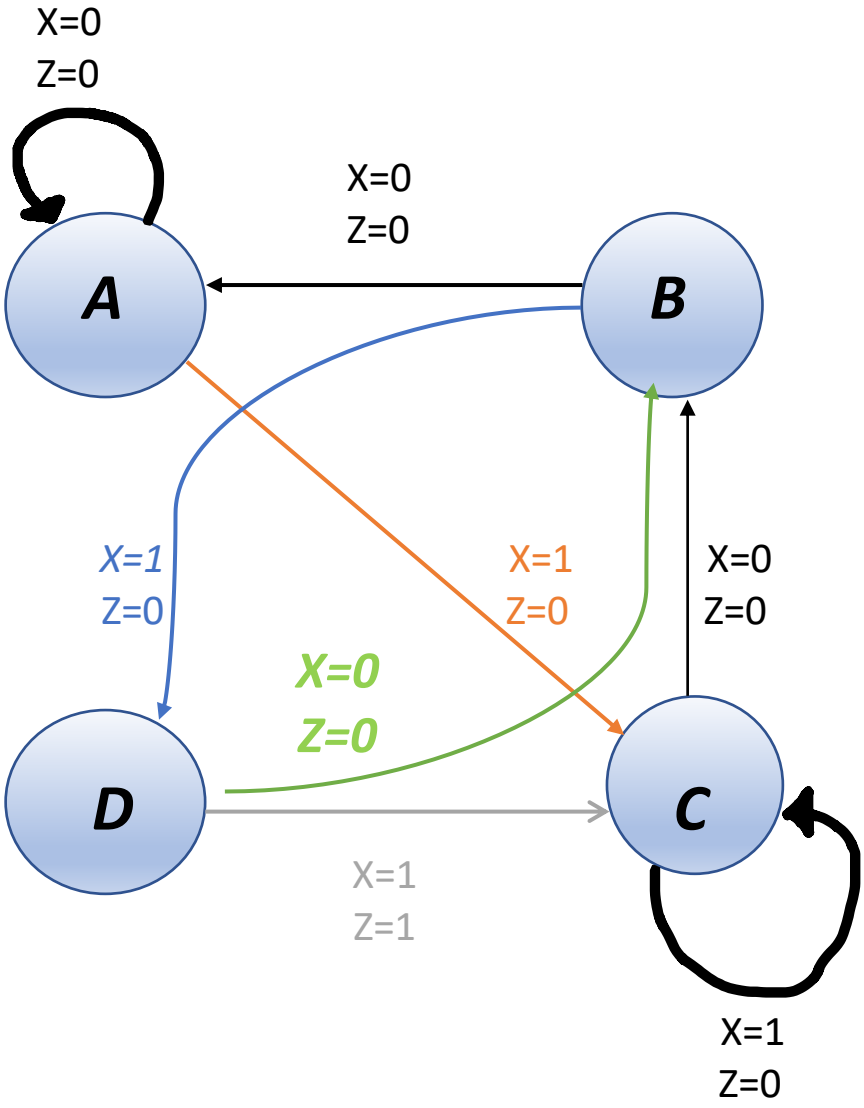
$Q_1^+Q_0^+Z$ / Q_1Q_0	X = 0	X = 1
00	00,0	10,0
01	00,0	11,0
10	01,0	10,0
11	01,0	10,1

To make the table more understandable we assign state names to state codes.

00:A
01:B
10:C
11:D

$Q_1^+Q_0^+Z$ / Q_1Q_0	X = 0	X = 1
A	A,0	C,0
B	A,0	D,0
C	B,0	C,0
D	B,0	C,1

- Draw the state transition diagram.



2. Assume that the machine is in state 00 and the output is also 0. Write the shortest possible sequence of X (consecutive values of X) that makes the output 1.

I. Initially machine is in state 00 so machine is in A state.
II. If X=1 is given new state is c and output is 0.
III. Then we give X=0 so new state is B and output is 0.
IV. Then we give X=1 so machine is In state D and output is 0.
V. Finally, we give X=1 so machine is in state C and output is 1.

Sequence of X: 1 → 0 → 1 → 1