Gage Farmer

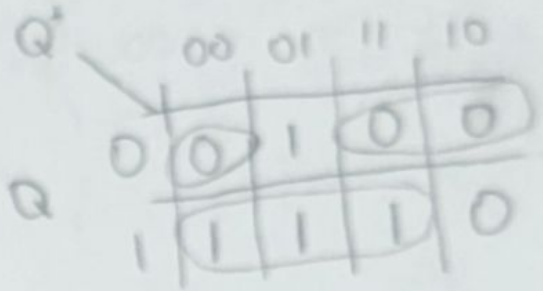
ECE 3561 HW 01 Phillips

Homework 01: Latches and Flip-Flops

Solve the **four** following problems. Show all your work/process. Please neatly write or type your answers, and please scan or upload your answers in a single PDF file to the assignment submission on Carmen. Answers may be graded for correctness, thoroughness, completion, or some combination.

1.1 An XY latch has two inputs X and Y, and one state variable Q. It operates as follows:

- If $X = Y$, the latch state does not change ($Q^+ = Q$).
- If $X = 0$ and $Y = 1$, the latch state becomes 1 ($Q^+ = 1$).
- If $X = 1$ and $Y = 0$, the latch state becomes 0 ($Q^+ = 0$).



a. Construct the state table for this XY latch. Circle the stable states.

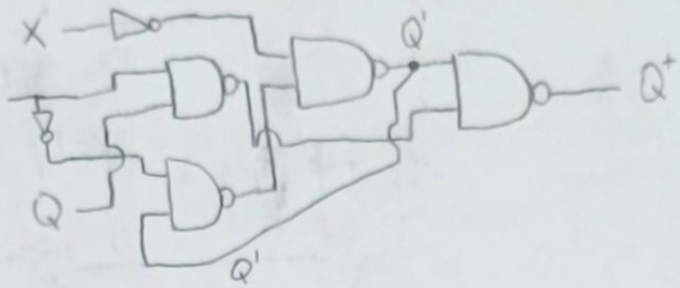
b. Derive the characteristic equation (next-state equation) for this XY latch. $Q^+ = X'Y + QX' + QY$

1) b) $Q^+ = x'Y + Qx' + QY$

c) $Q^+ = x'(Q+Y) + QY$

$Q^+ = x'(Q'Y')' + QY$

$Q^+ = [x'(Q'Y')]'[QY]'$



d) ~~No because each transition with potential between states has only predictable outputs for those between states~~

~~00 → 11 always between state of~~

Yes because going from 00 to 11 could either have a between state of 01 or 10, which results in 1 or 0.

e) ~~Output of $[x'(Q'Y')']$ because it determines~~

No

2) a) $P^+ = (BQ)'$

$Q = ((AB)'P)'$

P	AB 00	01	11	10
Q 0	1	1	1	1
1	1	0	0	1

$P = Q' + QB'$

b)

P^+	AB 00	01	11	10
QP 00	X	X	X	X
01	1	1	X	1
11	X	X	0	X
10	1	0	0	1

c) No, because the stable states define a path for each transition so they are all stable.

d) No, because ABQP = 0010 outputs $P^+ = 1$

= 1010 outputs $P^+ = 1$

both of which $Q' = 0$

so $Q' \neq P^+$

3) a) on spreadsheet

b) No, but only when B = 1, which locks P next into being 0, even when Q = 0

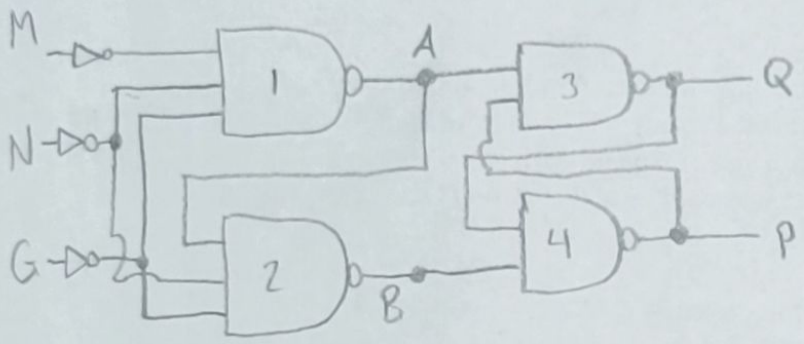
c) on spreadsheet

d) $A = (M+N+G)' \rightarrow ((M'N')'+G)' \rightarrow (((M'N')G')')' \rightarrow A = M'N'G' = (MNG)'$

$B = (A+N+G)' \rightarrow ((A'N')'+G)' \rightarrow (((A'N')G')')' \rightarrow B = A'N'G' = (ANG)'$

$Q = (A+P)' \rightarrow Q = A'P' = (AP)'$

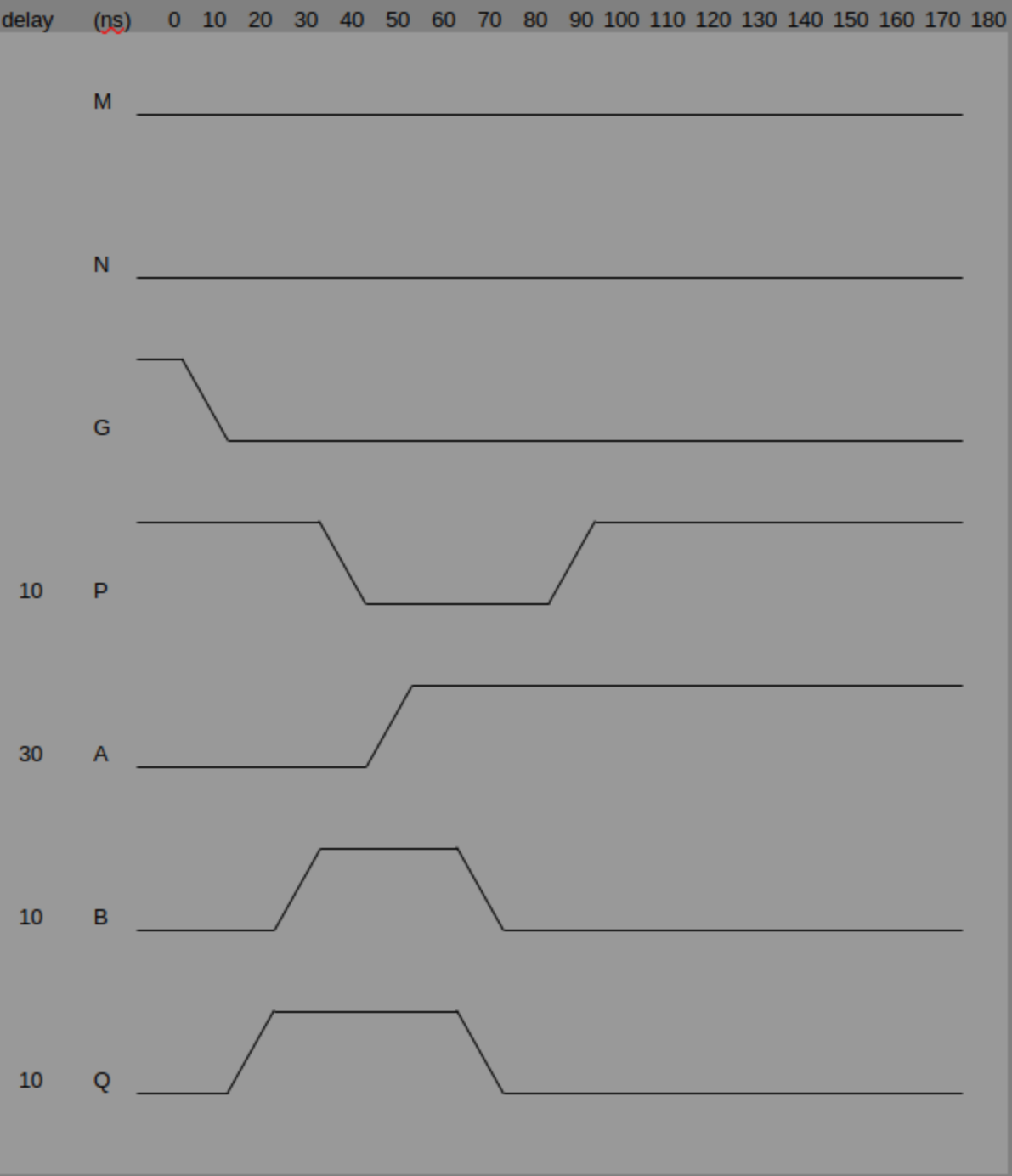
$P = (B+Q)' \rightarrow P = B'Q' = (BQ)'$



3a

M	N	G	P	A !(M+N+G)	B !(A+N+G)	Q !(A+P)	P Next !(Q+B)
0	0	0	0	1	0	0	1
0	0	0	1	1	0	0	1
0	0	1	0	0	0	1	0
0	0	1	1	0	0	0	1
0	1	0	0	0	0	1	0
0	1	0	1	0	0	0	1
0	1	1	0	0	0	1	0
0	1	1	1	0	0	0	1
1	0	0	0	0	1	1	0
1	0	0	1	0	1	0	0
1	0	1	0	0	0	1	0
1	0	1	1	0	0	0	1
1	1	0	0	0	0	1	0
1	1	0	1	0	0	0	1
1	1	1	0	0	0	1	0
1	1	1	1	0	0	0	1

3c Timing Diagram



1.4 Complete the following timing diagram for the rising-edge-triggered D flip-flop shown in Figure 3. Assume Q begins at 1. Make sure any propagation delays are clear on your diagram.

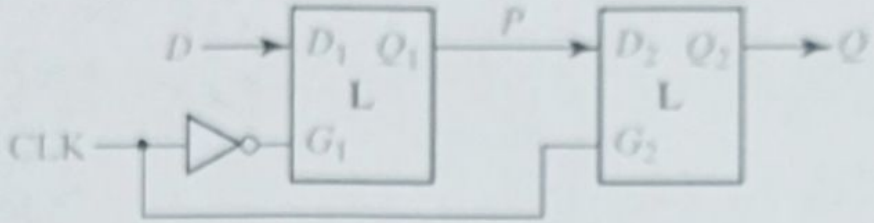


Figure 3: Rising-edge-triggered controller-responder D flip-flop circuit.