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ECE275 Midterm 2 2025

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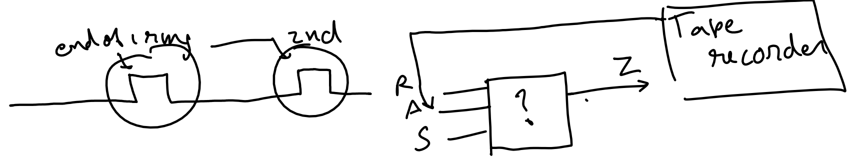
Student Name: Student Email:

1 Instructions

- There are ~~three~~ two problems. All problems are required.
- Maximum number of marks is 50. This exam amounts 10% toward the final grade.
- Time allowed is 50 minutes.
- In order to minimize distraction to your fellow students, you may not leave during the last 10 minutes of the examination.
- The examination is closed-book. One 8×11 in two-sided cheatsheet is allowed.
- Non-programmable calculators are permitted.
- Please use a pen or heavy pencil to ensure legibility. Colored pens/pencils are recommended for K-map grouping.
- Please show your work; where appropriate, marks will be awarded for proper and well-reasoned explanations.



Problem 1. *Give two Moore state transition tables for a sequential circuit to control a phone answering machine. The circuit should have three inputs (R, A, and S) and one output (Z). $R = 1$ for one clock cycle at the end of each phone ring. $A = 1$ when the phone is answered. S selects whether the machine should answer the phone after two rings ($S = 0$) or four rings ($S = 1$). To cause the tape recorder to answer the phone, the circuit should set the output $Z = 1$ after the end of the second ($S = 0$) or fourth ($S = 1$) ring, and hold $Z = 1$ until the recorder circuit answers the phone (i.e., when A goes to 1). If a person answers the phone at any point, A will become 1, and the circuit should reset. Assume that S is not changed while the phone is counting rings.*
(15 marks).

(Hint: You can draw two Moore state transition tables, one for $S = 0$ and one for $S = 1$. Fill in the following tables)

Table for $S = 0$

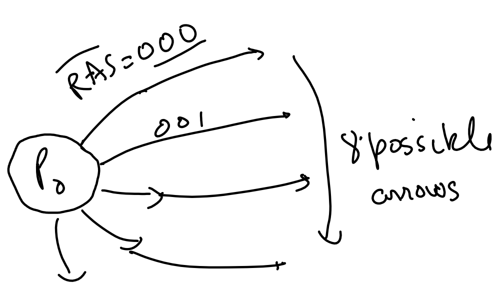
Unanswered Ring count	Present State	Next State $RAS = 000$	010	100	110	Output (Z)
0	P_0	P_0	P_0	P_1	P_0	0
1	P_1					
2	P_2					

Table for $S = 1$

Unanswered Ring count	Present State	Next State $RAS = 001$	011	101	111	Output (Z)
0	P_0	P_0	P_0	P_1	P_0	0
1	P_1	P_1	P_0	P_2	P_0	0
2	P_2	P_2	P_0	P_3	P_0	0
3	P_3	P_3	P_0	P_4	P_0	0
4	P_4	P_4	P_0	P_4	P_0	1

when S = 0 (two rings)

	RA = 00	01	10	11	Output Z
P_0	P_0	P_0	P_1	P_0	0
P_1	P_1	P_0	P_2	P_0	0
P_2	P_2	P_0	P_2	P_0	1



P_0 = counted 0 rings so far
P_1 = " 1 " " "
P_2 = " 2 " " "

Problem 2. *Determine the propagation delay and contamination delay of the circuit in Figure 2.83. Use the gate delays given in Table 2.8. (5 marks).*

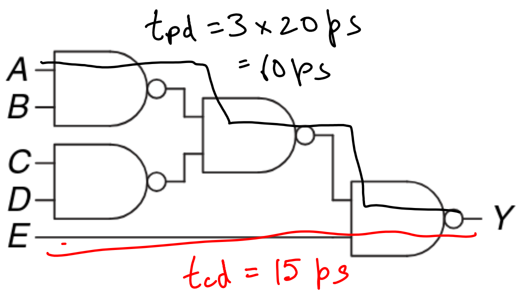
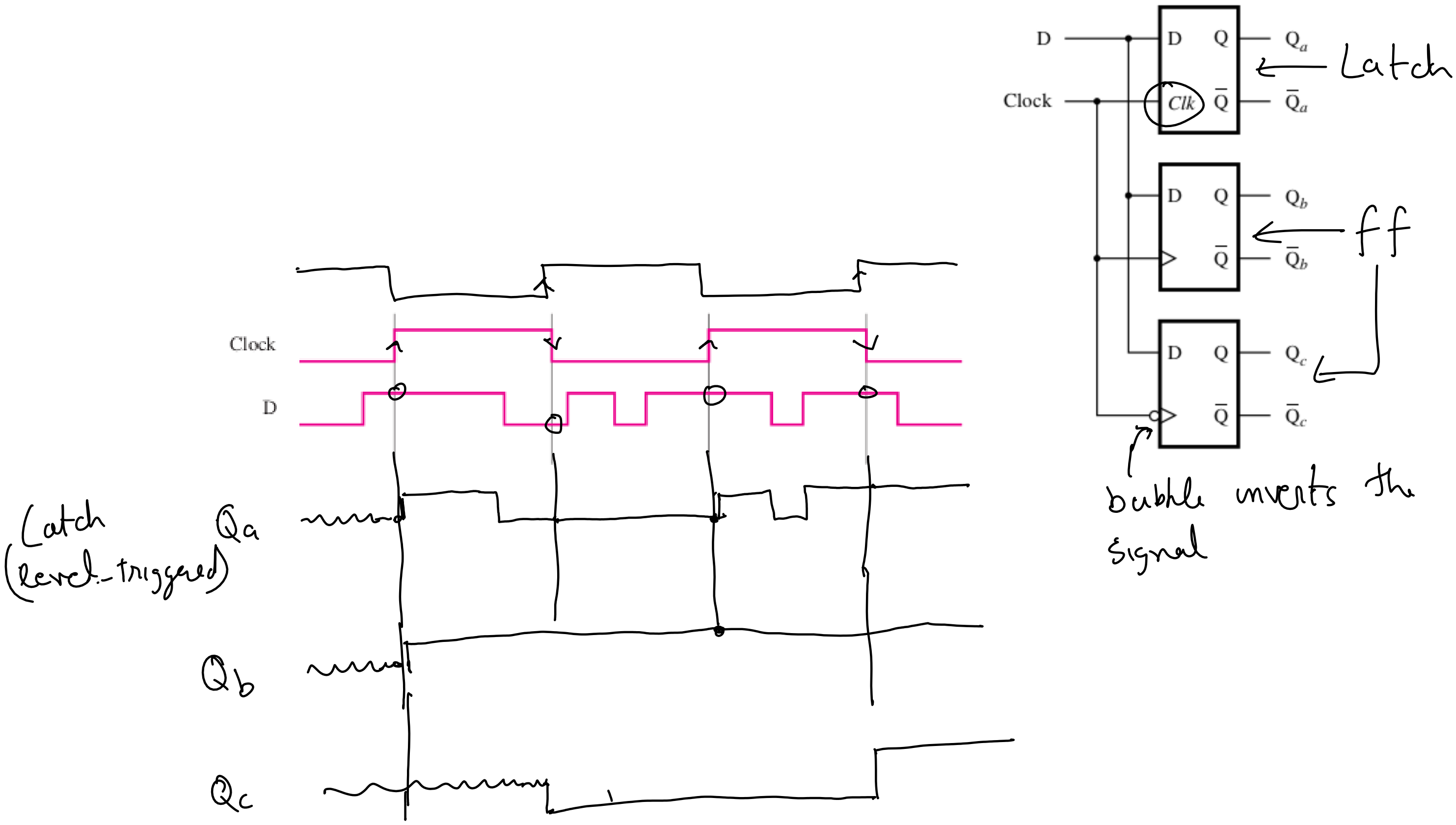


Figure 2.83 Circuit schematic

Table 2.8 Gate delays for Exercises 2.43–2.47

Gate	t_{pd} (ps)	t_{cd} (ps)
NOT	15	10
2-input NAND	20	15
3-input NAND	30	25
2-input NOR	30	25
3-input NOR	45	35
2-input AND	30	25
3-input AND	40	30
2-input OR	40	30
3-input OR	55	45
2-input XOR	60	40

Problem 3. *Consider the timing diagram in Figure 1. Assuming that the D and Clock inputs shown are applied to the circuit in Figure 1, Draw waveforms for the Q_a , Q_b , and Q_c signals. (10 marks)*



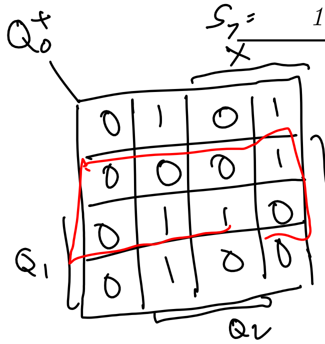
Problem 4. *Find the expression for J_0 and K_0 assuming that J_0 and K_0 are inputs to the J-K flip flop that capture the state of the least significant bit Q_0 of the following state encoded table. The state encoding table given with state encoding denoted as $Q_2Q_1Q_0$. (20 marks).*

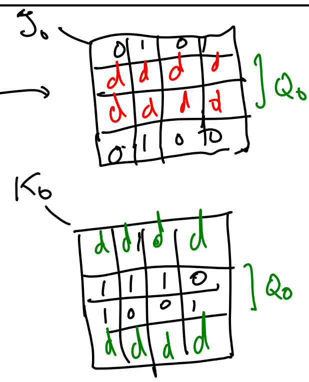
Present State	Next State		Output	
	$X=0$ ← input	$X=1$	$X=0$	$X=1$
$Q_2Q_1Q_0$	$Q_2^+Q_1^+Q_0^+$	$Q_2^+Q_1^+Q_0^+$	Z ← output	Z
$S_0 =$ 000	100	101	1	0
$S_1 =$ 001	100	101	0	1
$S_3 =$ 010	000	000	1	0
011	000	000	0	1
100	111	110	1	0
101	110	110	0	1
110	011	010	1	0
$S_7 =$ 111	011	011	0	1

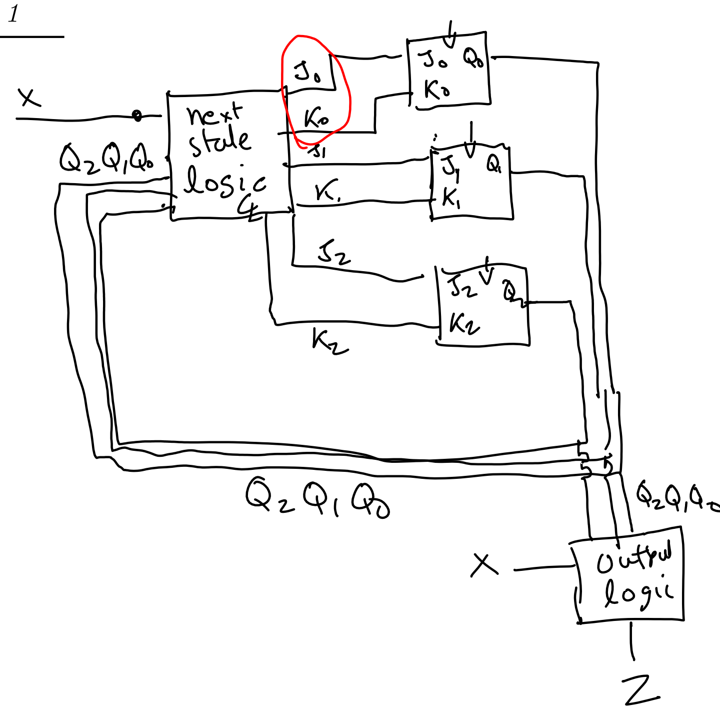
Excitation table

Q_0	Q_0^+	J_0	K_0
0	0	0	d
0	1	1	d
1	0	d	1
1	1	d	0

$K_0 = \overline{Q_0^+}$







X	Q_2	Q_1	Q_0	J_0	K_0
0	0	0	0	0	d
0	0	0	1		