Ryerson Polytechnic University
Department of Electrical & Computer Engineering
ELE328 – Digital Systems

Test No. 1 **October 22, 1997**

Name: ______________________ **Section:** __________

Notes:

1. Time Limit: 1 hour and 50 minutes
2. Answer all questions in the space provided
3. Closed Book

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1. A digital logic circuit inputs two 2-bit binary numbers $A = A_1\ A_0$ and $B = B_1\ B_0$ and produces the output $Z = Z_1\ Z_0$, where Z = A if A > B, Z = B if B > A and Z = 1 1 if A = B.

   (a) Construct a truth table for the system. **(1 mark)**

   (b) Draw the K-maps for both Z_1 and Z_0. **(2 marks)**

   (c) Derive the simplest Sum of Products expressions for Z_1 and Z_0. **(2 marks)**

2. Given the following Register Circuit:

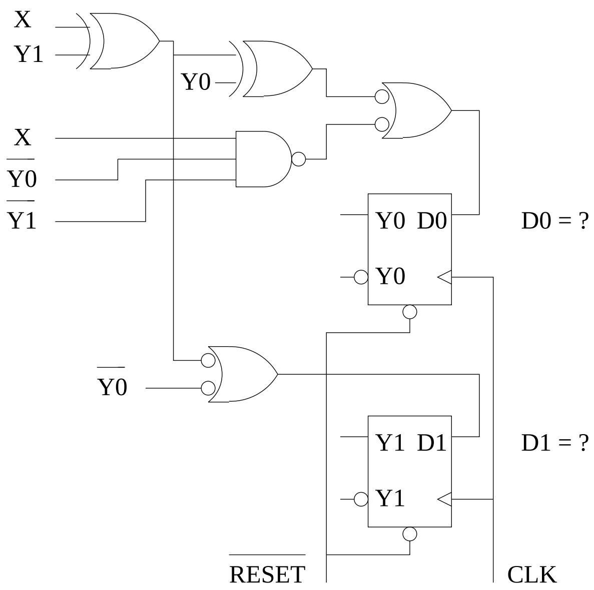


Figure 1: Synchronous Sequential Circuit

(a) Given the following timing parameters, calculate the maximum clock frequency. **(2 marks)**

FF delay = 20 nS.
t_{setup} = 10 nS.
t_{hold} = 5 nS.
t_{NAND} = 10 nS. $\qquad T_{min}$ = ?
t_{X-OR} = 15 nS.
t_w min = 30 nS. $\qquad f_{max}$ = ?
Add 20% safety factor

(b) For the above sequential synchronous circuit, derive the equations for D_0 and D_1 as functions of X, Y_0 and Y_1. Show answer on Figure 1. **(2 marks)**

(c) Place the functions for D_0 and D_1 on Karnaugh maps. **(2 marks)**

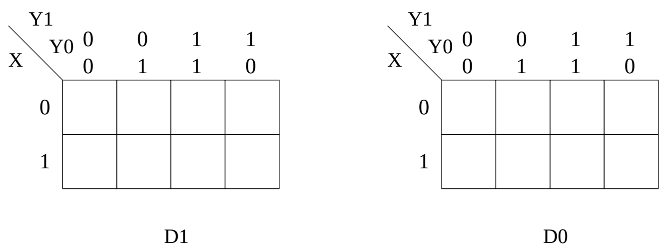


Figure 2: Karnaugh Maps

(d) Construct a transition table for the above circuit. **(3 marks)**

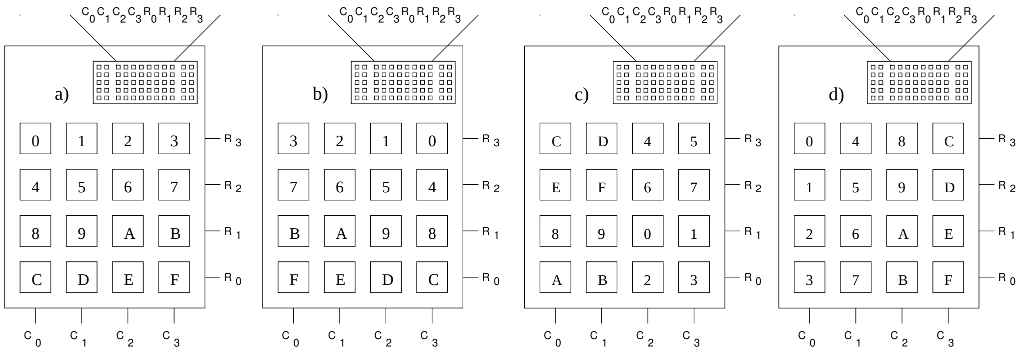
PRESENT			NEXT	
X	Y1	Y0	D1	D0
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Figure 3: Transition Table

(e) Derive the correct state diagram, assuming S0 $= \overline{Y_1}\,\overline{Y_0}$, S1 $= \overline{Y_1}\,Y_0$, S2 $= Y_1\,\overline{Y_0}$, S3 $= Y_1\,Y_0$. **(3 marks)**

Figure 4: State Diagram

3. For the following hardware encoder circuit, the key arrangement must be: **(3 marks)**



e) None of the above

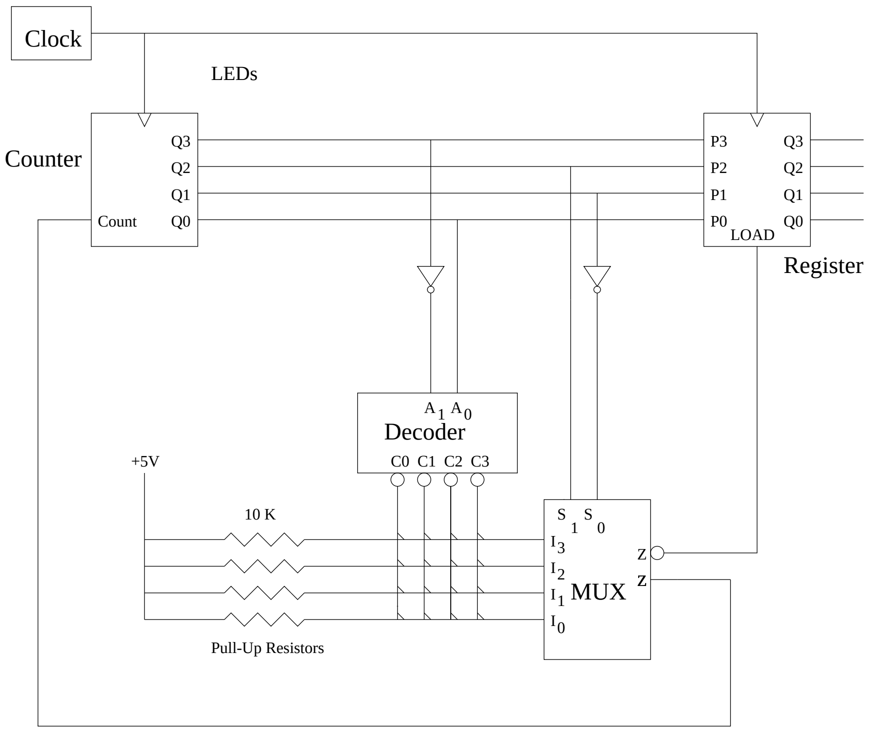


Figure 5:

4. Given the following Register Circuit:

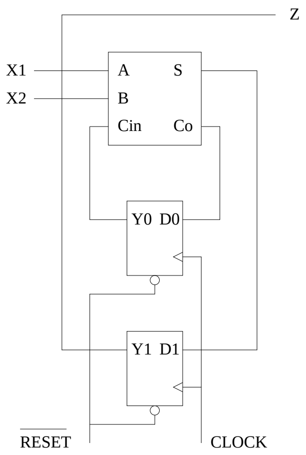


Figure 6: Synchronous Sequential Circuit

(a) Sketch the correct output waveforms at Cin, Co, S and Z in their proper time relationship to the following input waveforms. **(4 marks) Note:** Both flip-flops are initially set as indicated.

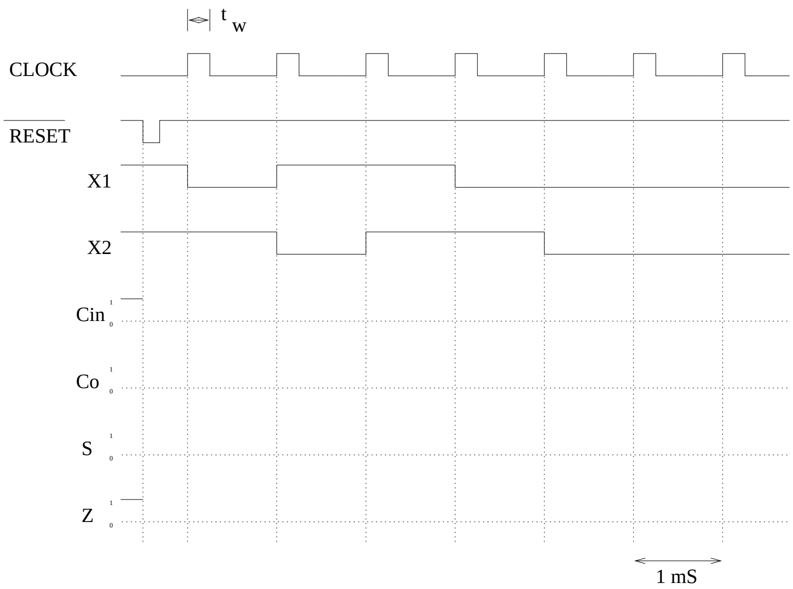


Figure 7: Waveforms

(b) What is the purpose of this circuit? **(1 mark)**