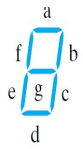
Department of Computer Science
National Chiao Tung University

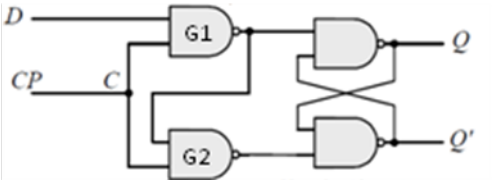
Digital System Design

Second Midterm Exam 12/06/2012

1. (10%) Derive the optimal (simplified) two-level NOR-OR implementation of $f(x,y,z) = x'y'z'+x'z+y'z$.

2. (18%) Consider the following display (left) for BCD-to-seven-segment decoder.
   (a) Implement ***a, b, c, d*** using a decoder and external gates (with least wires).
   (b) Implement ***e*** with an 8x1 multiplexer and an inverter.





3. (10%) Consider the above circuit (right). Obtain the output values of G1 and G2 for different values of *CP* and *D* inputs to show that it is a *D*-latch.

4. (10%) Implement a four-bit (even) parity generator using a 4x1 multiplexer and minimum number of logic gates.

5. (10%) Design a code converter that converts a decimal digit from the 2421 code to BCD, with $d(w,x,y,z) = \sum(5,6,7,8,9,10)$.

6. (16%) Consider a sequential circuit with a *D* flip-flop *A*, a *JK* flip-flop *B*, an input *x*, and an output *z*, with the following input/output equations

$$D_A = Ax', \quad J_B = x, \quad K_B = Ax+B, \quad z = Bx'$$

Derive the state table of the circuit.

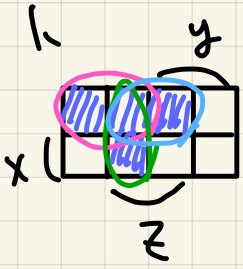
7. (18%) Derive the state table and state diagram of a sequential circuit with three *T* flip-flops (*A*, *B*, and *C*), as described by the three input equations:

$$T_A = BC, \quad T_B = C, \quad T_c = 1.$$

Assume that each flip-flop has a propagation delay of 15ns, a setup time of 10ns, a hold time of 5ns, and the AND gate has a propagation delay of 5ns. Obtain the maximum clock frequency that the circuit can operate correctly (according to the state diagram).

8. (8%) Explain the purpose of the *carry lookahead* logic for a binary adder. Give the carry output of the second stage of a 4-bit adder as a function of input carry C_0 and carry generate/propagate signals.

1.

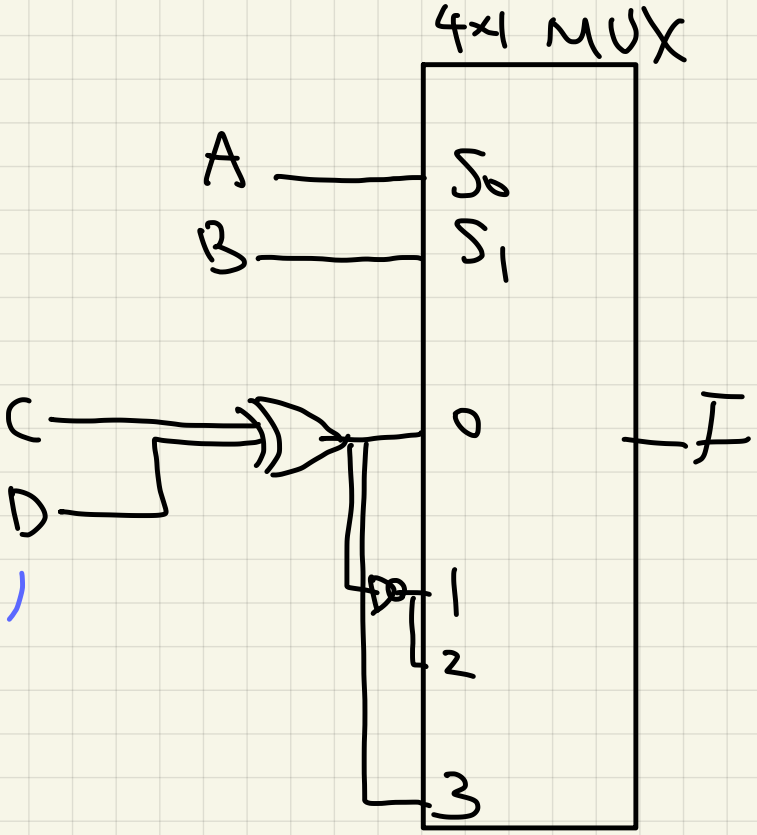


$f = x'y' + y'z + x'z$

$= (x+y)' + (y+z')' + (x+z')'$

4.

A	B	C	D	F	
0	0	0	0	0	
0	0	0	1	1	$F = C \oplus D$
0	0	1	0	1	
0	0	1	1	0	
0	1	0	0	1	
0	1	0	1	0	$F = (C \oplus D)'$
0	1	1	0	0	
0	1	1	1	1	
1	0	0	0	1	
1	0	0	1	0	$F = (C \oplus D)'$
1	0	1	0	0	
1	0	1	1	1	
1	1	0	0	0	
1	1	0	1	1	$F = C \oplus D$
1	1	1	0	1	
1	1	1	1	0	



5.