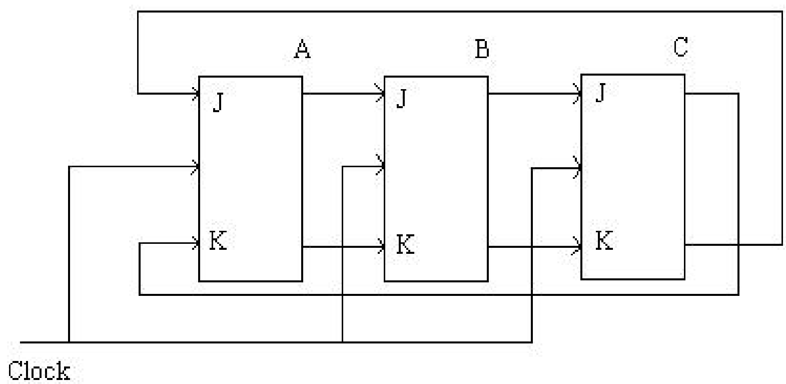
CS150, Fall 1995
Quiz #2
Professor I. Koren

Problem #1

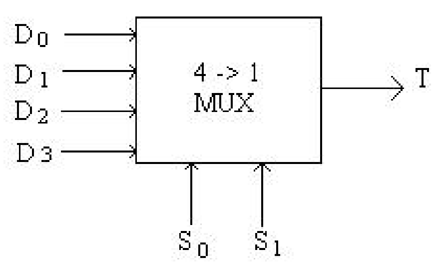
A Twisted Tail Ring counter is shown below. Show the state diagram, accounting for all possible states? Is this counter self-starting (self-correcting)? Explain.



Problem #2

A 4 --> 1 MUX (Multiplexer) shown below can be used to realize any 3-variable switching function with no added logic gates. In this problem we will try to find out whether a given 4-variable switching function *f(W, X, Y, Z)* can be realized using a single 4 --> 1 MUX *with no added gates.*

$S_0 S_1$	T
00	D_0
01	D_1
10	D_2
11	D_3



Problem #2a

Given the function *f(W, X, Y, Z)* = (Sigma)m(2, 3, 4, 6, 7, 15) + (Sigma)d(0, 5, 12, 13) and its K-map, is it possible to realize it using a single 4 --> 1 MUX by choosing S_1 S_0 = W X, D_i (a member of) {0, 1, Y, not Y, Z, not Z} ; i = 0, 1, 2, 3 (the complements of the input variables are available). If your answer is positive show the realiziation; if it's negative explain why.

Problem #2b

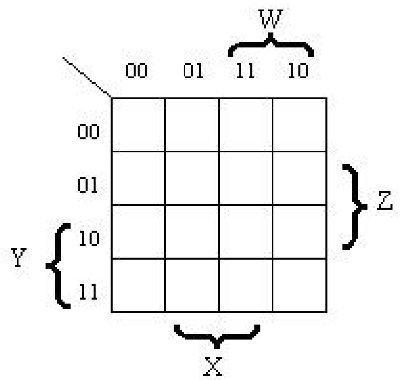
Repeat (a) for the choice S_1 S_0 = Y Z.

Problem #2c

Repeat (a) for the choice S_1 S_0 = W Z.

Problem #2d

How do you check with the aid of K-maps, the possibility of realizing a given 4-variable function using a single 4 --> 1 MUX?



Problem #2e

Estimate the percentage of 4-variable functions which can be realized using a single 4 --> 1 MUX.

Problem #3

State whether each of the following is true or false. If true prove or explain, if false give a counter example. A correct True or False ansewr with no explanation is worth only 1 point.

Problem #3a

No static hazards may occur when implementing a 4-variable logic function using a 4-to-16 decoder.

Problem #3b

The radix-4 modified Booth algorithm which examines three multiplier bits at once (with the rightmost bit serving as a reference bit) always results in the minimum number of add/subtract operations.

Problem #3c

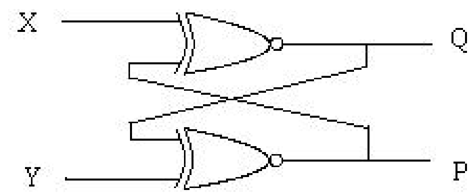
A 2048 X 1 ROM can be used to implement an 8:1 MUX.

Problem #3d

Every finite state machine can be implemented as a Linear-Feedback-Shift-Register (LFSR).

Problem #3e

The following circuit can serve as a Flip-Flop in any sequential circuit.



Problem #4

Show an implementation of a circuit that multiplies the (unsigned) input number X = x_4 x_3 x_2 x_1 x_0 by 7 using only Full Adders (FAs) and inverters. In other words, the output number Z = z_{n-1} z_{n-2} ... z_1 z_0 satisfies Z = 7 * X. Determine the required number ofoutput bits, n, and show the implementation of your Multiply-by-7 circuit using as few FAs and inverters as possible.
