CIS 251-002 Final, Spring 2003 Exam #: _____ Name: _____
First Last

Prof. David Nassimi (Time: 2 hours) SS #: _____-_____-_____

1(a) Use a truth table to find a sum-of-minterms expression for the exclusive-or function $A \oplus B$.

	GRADE	
1		/20
2		/20
3		/20
4		/20
5		/20
SUM		/100

(b) Use algebraic manipulations to convert the following Boolean function to a simplified sum-of-products form.

$$f = (X + Y) \oplus Z$$

(c) Use a truth table to compute the above function f starting with its original form. Then, use a map to find a simplified sum-of-products form.

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2. Use formal procedures to design a synchronous 4-state **gray-code counter** with D type flip-flops (Y_1, Y_0). The counter has repeated consecutive counts

$$00, 01, 11, 10.$$

The counter has **no external inputs** (except the CLOCK), and it advances its count every clock cycle. Draw the final circuit.

3. A synchronous sequential circuit has two flip-flops (Y_1, Y_0) and an external input X. The flip-flops are T type and have the following input equations:

$$T_1 = X\overline{Y_0}, \quad T_0 = X.$$

Use formal procedures to **analyze** the circuit. Derive the state transition table and state diagram. Describe what the circuit does.

4. A sequential circuit (sequence detector) has a serial input X and an output Z. Whenever the circuit receives a sequence of 0001 (three consecutive 0 followed by a 1), it produces an output $Z = 1$ at the same time as the fourth input. At all other times, the output $Z = 0$. An example input/output sequence is shown below.

X: 0 0 **<u>0 0 0 1</u>** 0 0 1 1 1 1 **<u>0 0 0 1</u>** 1 1 0 0 $\cdots$
Z: 0 0 **<u>0 0 0 1</u>** 0 0 0 0 0 0 **<u>0 0 0 1</u>** 0 0 0 0 $\cdots$

Starting with an initial state A, obtain a state diagram for this sequence detector. (You don't need to carry out the rest of the design.)

5. A 3-bit *shifter circuit* is a **combinational circuit** with a 3-bit input (A_2, A_1, A_0) and a 3-bit output (Z_2, Z_1, Z_0). The circuit has two control inputs (S_1, S_0) which specify the operation to be performed as follows:

S_1	S_0	Action	Example
0	0	*Straight*	If input is 011, output is 011.
0	1	*Right Rotate*	If input is 011, output is 101.
1	0	*Left Rotate*	If input is 011, output is 110.
1	1	Not used.	

(a) Write the Boolean equation for output bit Z_0.

(b) Draw the complete circuit for the 3-bit shifter circuit using a decoder and AND-OR gates.