INEL 4206 Fall 2002 Exámen I 11/22/02

Nombre: _____ Sección: _____

¡Anota tu nombre y número de sección en <u>todas las hojas</u> del examen AHORA! (penalidad de 5 puntos)

Tienes 2 horas para completar tres problemas. Lee cuidadosamente todo el examen antes de empezar a trabajar. Muestra todo el trabajo conducente a tu contestación. Podrás recibir crédito parcial por contestaciones parciales siempre y cuando muestres tu trabajo por escrito. Usa tu tiempo inteligentemente. Exito!

INEL 4206 Staff

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1	/30
2	/15
3	/25
4	/20
5	/10
Total	/100

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Problem 1. (30 points) Finite State Machines

Consider the following finite state machine that cyclically counts by twos whenever the input signal is 1. After counting up to six, the machine begins counting from 0 again. For instance, suppose that the machine receives the sequence 101101. The machine should end up in state 0, since the remainder of it increments by 2 four times. For this input, the sequence of states traversed by the machines is:

$$0 \rightarrow 2 \rightarrow 2 \rightarrow 4 \rightarrow 6 \rightarrow 6 \rightarrow 0$$

The machine's state number represents the current count of the number represented by the binary sequence of bits received so far.

(a) **(5 points)** Write the sequence of states traversed by the machine for the input sequence 10101011.

```
0 -> 2 -> 2 -> 4 -> 4 -> 6 -> 6 -> 0 -> 2
```

(b) **(5 points)** Determine the number of flip-flops necessary to implement a sequential circuit implementing the above FSM.

```
2 flip flops
```

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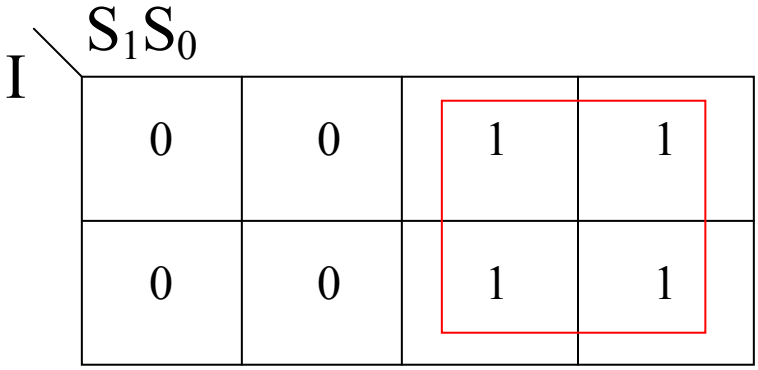
(c) **(10 points)** Complete the following state transition table for the sequential circuit. The circuit should output the binary 3-bit representation of the current state number. For instance, if the machine is in state 6, the output should be 110.

Current State Number	Current State Encoded S_1S_0	Input	Next State Encoded	Outputs (3 bits) $O_2O_1O_0$
0	00	1	01	000
0	00	0	00	000
2	01	1	10	010
2	01	0	01	010
4	10	1	11	100
4	10	0	10	100
6	11	1	00	110
6	11	0	11	110

(d) **(10 points)** Provide Kmap and minimal Boolean equations for the high low order bit O_0 of the output. Show all your work.



O_2

$$O_2 = S_1$$

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Problema 2. (15 points) Problem Set I

a) (5 points) In the circuit developed inProblem Set I, ff I wanted my LED Scanner to have 8 LED's instead of 5, what additional data and changes would I need? on the Truth Table of part 1 (Transition table)

Input				Output			
I_0	I_1	I_2	I_3	O_0	O_1	O_2	O_3
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	~~1~~ 0	1	~~0~~ 1	0
~~1~~ 0	1	~~0~~ 1	0	~~1~~ 0	~~0~~ 1	1	1
~~1~~ 0	~~0~~ 1	1	1	1	~~0~~ 1	1	0
1	~~0~~ 1	1	0	~~0~~ 1	~~0~~ 1	0	1
1	1	0	1	1	1	0	0
1	1	0	0	1	0	1	1
1	0	1	1	1	0	1	0
1	0	1	0	1	0	0	1
1	0	0	1	0	0	0	0

b) (5 points) Briefly describe the changes on the decoder.

The new decoder is simply a normal 3 to 8 decoder. Previously the logic was simplified by several don't cares.

c) (5 points) Would you need more flip flops to store information for the 3 new LEDs?

NO

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Problema 3. (25 points) The Case of the Mysterious Easy I Program

a) (10 points) The following table shows the machine code version of a mysterious Easy I program. Your job is to reconstruct the assembly language version of the code and fill the corresponding column. You may refer to Appendix A for information on the Easy I ISA.

Instruction Address	Assembly Code	Machine Code (binary)
100	ANDi 0	0 00110 0000000000
102	STOREi 512	0 00100 1000000000
104	ADDi 6	0 00111 0000000110
106	STOREi 514	0 00100 1000000010
108	ADDi 1	0 00111 0000000001
110	STOREi 516	0 00100 1000000100
112	LOOP: LOADi 516	0 00101 1000000100
114	BrNi END	0 00010 0010001000
116	LOADi 514	0 00101 1000000010
118	ADD 512	1 00111 1000000000
120	STOREi 512	0 00100 1000000000
122	ANDi 0	0 00110 0000000000
124	ADDi 1	0 00111 0000000001
126	COMP	0 00000 dddddddddd
128	ADDi 1	0 00111 0000000001
130	ADD 516	1 00111 1000000100
132	STOREi 516	0 00100 1000000100
134	JUMPi LOOP	0 00011 0001110000
136	END:	

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b) (10 points) Provide a High Level Language version (C, C++, etc.) of the same program:

```
product = 0;
A = 6;
B = 7;
while (B >= 0) {
        product += A;
        B --;
}
```

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Problema 4. (20 points) Computing Models and More …

In class we studied the computational limits of different computing models. For each of the problem statements below, indicate the least powerful computing model that can solve the problem and concisely justify your answer (1-2 short senteneces). You may want to state why the less powerful models can't solve the problem and why the model chosen can solve it.

Consider only the following models:

- Combinational logic circuits
- Sequential logic circuits
- Turing Machines
- Some model more powerful than a Turing Machine

a) (5 points) Compute the sum of two N bit numbers for fixed N

Combinational Circuit

A set of 1-bit full adders can be combined to solve this problem.

b) (5 points) Compute the sum of two N numbers for any N

Turing Machine

Simpler models no capable of storing an arbitrarily big result.

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c) (5 points) Determining if a C++ program has a syntactic error. For instance, determining if the program is missing a curly brace } somewhere.

Turing Machine

Simpler model not capable of remembering an arbitrarily many nesting levels

d) (5 points) Determining if a C++ program has an infinite loop

Model more powerful than Turing Machine

This is simply an instance of the Halting problem shown unsolvable by TM's by Turing himself.

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Problema 5 (10 points) Evaluación del curso

Es importante que completes esta parte con la mayor seriedad e interés posibles. Tu contribución ayudará a mejorar la calidad del curso significativamente.

Gracias.

1) Menciona los tres aspectos que mas te gustan de la clase INEL 4206

a)

b)

c)

2) Menciona los tres aspectos que menos te gustan de la clase INEL 4206

a)

b)

c)

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Appendix A. Easy I processor essentials