Department of Electrical and Computer Engineering
The University of Texas at Austin

EE 306, Fall, 2004
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Exam 1, October 06, 2004

Name:______________________________

Problem 1 (17 points):__________

Problem 2 (23 points):__________

Problem 3 (15 points):__________

Problem 4 (15 points):__________

Problem 5 (10 points):__________

Problem 6 (20 points):__________

Total (100 points):____________________

Note: Please be sure that your answers to all questions (and all supporting work that is required) are contained in the space provided.

Note: Please be sure your name is written legibly on each sheet of the exam.

I will not cheat on this exam.

____
Signature

GOOD LUCK!

Name:________________________________

Problem 1 (17 points):

Part a (3 points): An instruction set consists generally of three kinds of instructions:

____________________, an example of which is ____________________,

____________________, an example of which is ____________________,

____________________, an example of which is ____________________.

Part b (3 points): If one can implement any logic function using many copies of a single gate (or a set of gates), then we say that single gate (or set of gates) is

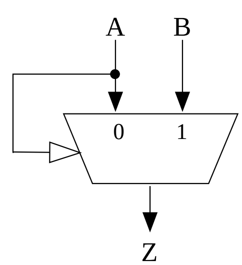
Answer:

Part c (3 points): A ________________ variable is a variable that can have one of exactly two values. It gets its name from the fact that originally the two values were TRUE and FALSE, and the awareness that the value of such a variable must be exactly one of these two values.

Part d (4 points): If you know R1 XOR R2 = 0, what can you infer about the contents of any of the registers R0 to R7?

Part e (4 points): What logic structure does this circuit implement? Hint: Fill out the truth table.

A	B	Z
0	0	
0	1	
1	0	
1	1	



Name:________________________________

Problem 2 (23 points):

Part a (8 points): The following LC-3 instruction is fetched, loaded into the IR, decoded, and executed.

15				11	10	9									0
0	0	0	0	**a**	**b**	**c**	0	0	0	0	0	0	0	0	0

Note that bits [11:9] can each be 0 or 1. In ten words or fewer, what USEFUL information do bits a, b, and c provide in the execution of the particular 16-bit instruction shown above. Put your answer in the box below:

Hint: Be careful.

Answer:

Part b (7 points): The LC-3 has just executed exactly ten instructions. An examination of the behavior during each clock cycle reveals that exactly one of the ten instructions was a branch (opcode=0000) and the rest were some number of LDR, LD, and AND instructions. Exactly 16 memory accesses were made during the time these ten instructions were executed. How many AND instructions were executed? Put your answer in the box below:

Answer:

Name:________________________________

Part c (8 points): Your task is to write a program segment of three consecutive LC-3 instructions in the boxes provided below. The first instruction is to set one of the three condition codes. The second instruction is to set one of the other two condition codes. The third instruction is to set the third condition code. **You must use a different opcode in each of the three instructions.**

The initial state of the LC-3 (i.e., the contents of the registers, memory, etc. prior to the execution of your three instructions) is not known to you.

Note: In the box below each instruction, specify which condition code the instruction sets.

Instruction 1:

15															0

CC Set:

Instruction 2:

15															0

CC Set:

Instruction 3:

15															0

CC Set:

Name:________________________________

Problem 3 (15 points): Recall the standard IEEE 32-bit floating point data type wherein normalized numbers having values $(-1)^{sign} * 1.fraction * 2^{(exponent-127)}$ are expressed with 1 bit of sign, 8 bits of exponent, and 23 bits of fraction.

In this problem, we will define an 8-bit floating point data type, where we use 1 bit for the sign, 4 bits for the exponent, using an excess-9 code (i.e., BIAS = 9), and 3 bits of fraction.

Part a (7 points): Show the representation for 3 $\frac{1}{4}$ in this data type:

7							0

Part b (8 points): What is the largest positive normalized number that can be expressed with this 8-bit floating point data type?

Name:______________________________

Problem 4 (15 points): Alarm clocks normally ring when the hour reaches a preset time. We would like to design a more sophisticated alarm clock such that the output (the signal to make the alarm clock ring) occurs as follows: If it is a weekday (Monday through Friday), we wish the alarm clock to ring when the time reaches 7am. If it is the weekend (Saturday, Sunday), and the sun is shining, we still wish the alarm clock to ring at 7am so we can play golf. If the sun is not shining on the weekend, we wish the alarm clock to ring at 9am so we can sleep late. We note that a simple four-input, one-output logic circuit is sufficient to produce the output that will make the alarm ring.

Part a (3 points): The four inputs are:

A: ________________

B: ________________

C: 7am (no = 0, yes = 1)

D: 9am (no = 0, yes = 1)

Hint: Each input must be a logical variable.

Part b (6 points): Complete the truth table for the alarm clock logic circuit

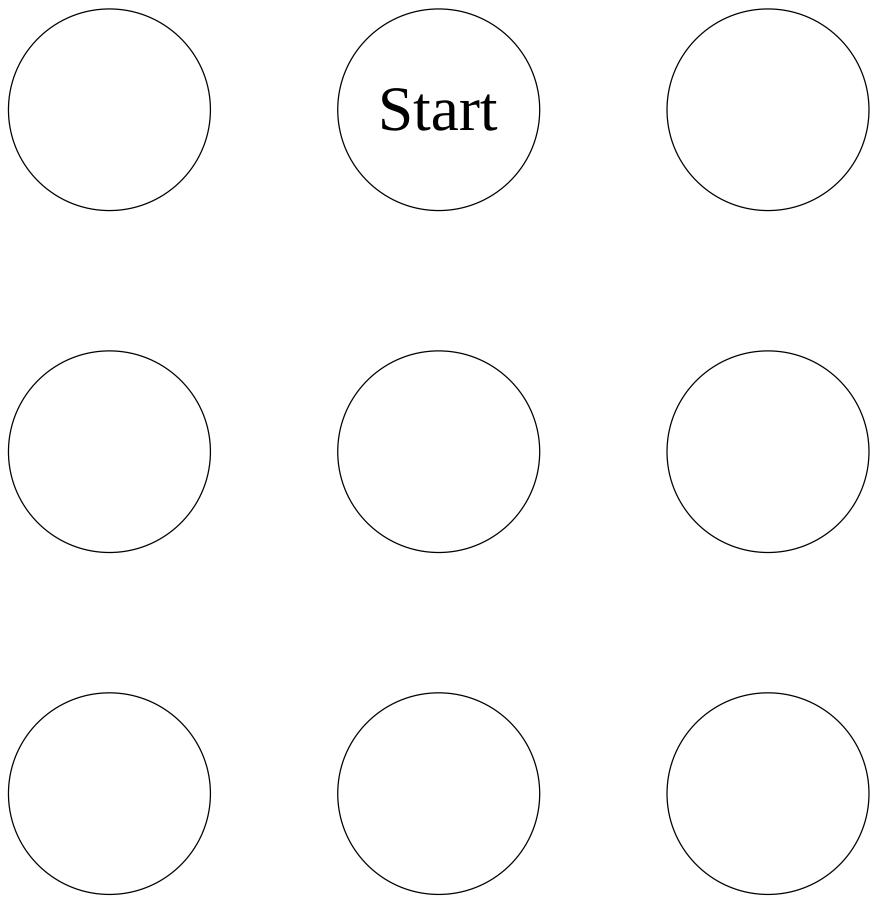
A	B	C	D	Out
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

Part c (6 points): Show the gate-level logic circuit needed to drive the alarm. Use only AND, OR, and NOT gates.

Name:________________________________

Problem 5 (10 points): A game of a chance uses a die (the singular of dice) which has the numbers 1, 2, and 3 on its six faces (two occurrences of each). The game consists of rolling the die twice. If the sum of the two rolls is 6, you win \$20. If the sum of the two rolls is 5, you win \$10. Else, you win nothing. After the two rolls, you press a button to return to the initial state. Complete the description of the Finite State Machine

below to show all possible states, state transistions, and outputs. Clearly label the outputs associated with each state. [Note: you may not need to use all of the nine potential states that we provided.]



For later amusement (NOT part of this exam, and not to be thought about while taking the exam right now!): If it costs you \$5 to play each game, and you start with a lot of money, do you eventually get rich or go broke.

Name:________________________________

Problem 6 (20 points): Listed below are the states of the registers of the LC-3 at two times during the execution of a single instruction. Given the information provided, fill in all 16 bits of the instruction that is being executed.

The instruction being executed is stored in location x3000 in memory. The first state is just **after** the instruction has been fetched and stored in the IR. The second state is **at the end** of the execution of the instruction, before the next instruction is fetched.

Note: Some data has been intentionally left out.

Register	**After Fetch**	**At End**
PC	x3001	x3001
MAR	x3000	x4020
MDR	x6???	x0000
R0	x5000	x0000
R1	x4000	x4000
R2	x3000	x3000
R3	x2000	x2000
R4	x1000	x1000
R5	x4040	x4040
R6	x5050	x5050
R7	x6060	x6060

15 0

x3000