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

EE 306, Fall, 2004
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Exam 2, November 10, 2004

Name:_____

Problem 1 (15 points):_____

Problem 2 (15 points):_____

Problem 3 (15 points):_____

Problem 4 (10 points):_____

Problem 5 (15 points):_____

Problem 6 (10 points):_____

Problem 7 (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 (15 points): Yale's short answer

Part a (3 points): As you know the memory address space of the LC-3 is 16 bits. If the MAR is loaded with the value xFE00, how does the hardware know to access the Keyboard Status Register or memory location xFE00.

(in 15 words or fewer, please)

Answer:

Part b (4 points): The following assembly program is assembled, and run on the LC-3 Simulator.

```
            .ORIG   x3000
            LD      R0, ASCII0
            TRAP    x21
            TRAP    x21
            TRAP    x21
            TRAP    x21
            TRAP    x21
            TRAP    x25
ASCII0      .FILL   x30
            .END
```

Before it is executed, you set a breakpoint at x3003. What happens? (in 15 words or fewer, please.)

Answer:

Part c (4 points): At the end of a LD instruction midway through the execution of a LC-3 program, the contents of the condition codes are set as follows N=1, Z=1, P=0. What can you infer? (in 15 words or fewer, please)

Answer:

Part d (4 points): There are three addressing modes available to the assembly language programmer who wishes to load a value from memory into R5. If the load instruction is in a loop and each time through the loop, the next consecutive memory location is loaded into R5, which addressing mode is most appropriate to use. Explain why. (in 15 words or fewer, please).

Answer:

Name:_____

Problem 2 (15 points):

What is the output of the following program?

```
            .ORIG x3000
            LD      R1, LETA
            LEA     R0, BUFFER
            STR     R1, R0, #0
            ADD     R1, R1, #1
            STR     R1, R0, #1
            ADD     R1, R1, #1
            STR     R1, R0, #2
            ADD     R1, R1, #1
            STR     R1, R0, #3
            TRAP    x22
            LD      R0, LF
            TRAP    x21
            LEA     R0, STRING
            TRAP    x22
            TRAP    x25
    LF      .FILL   x000A
    LETA    .FILL   x0041
    BUFFER  .BLKW   #4
    STRING  .STRINGZ    "EFGH"
            .END
```

Please write your answer in the box below in 15 words or fewer:

Answer:

Name:_____

Problem 3 (15 points):

Part a (10 points): Reverse-assemble the binary program (convert the binary program into an assembly language program). Most of the instructions have already been reverse-assembled for you, so your job is to complete the task.

Label	Assembly Language	Machine Language
	.ORIG x3000	0011000000000000
	AND R0, R0, x0	0101000000100000
	AND R1, R1, x0	0101001001100000
	ADD R1, R1, x9	0001001001101001
		0000100000000100
	LD R2, FF	0010010000001000
	LEA R3, FF	1110011000000111
		0111001011000010
	LEA R7, DD	1110111000000011
EE	NOT R5, R5	1001101101111111
	BRnz DD	0000110000000001
	NOT R4, R3	1001100011111111
		0110110010000001
	TRAP x25	1111000000100101
		1101000000000000
	.FILL xFF00	1111111100000000
	.FILL xFAFA	1111101011111010
	.END	

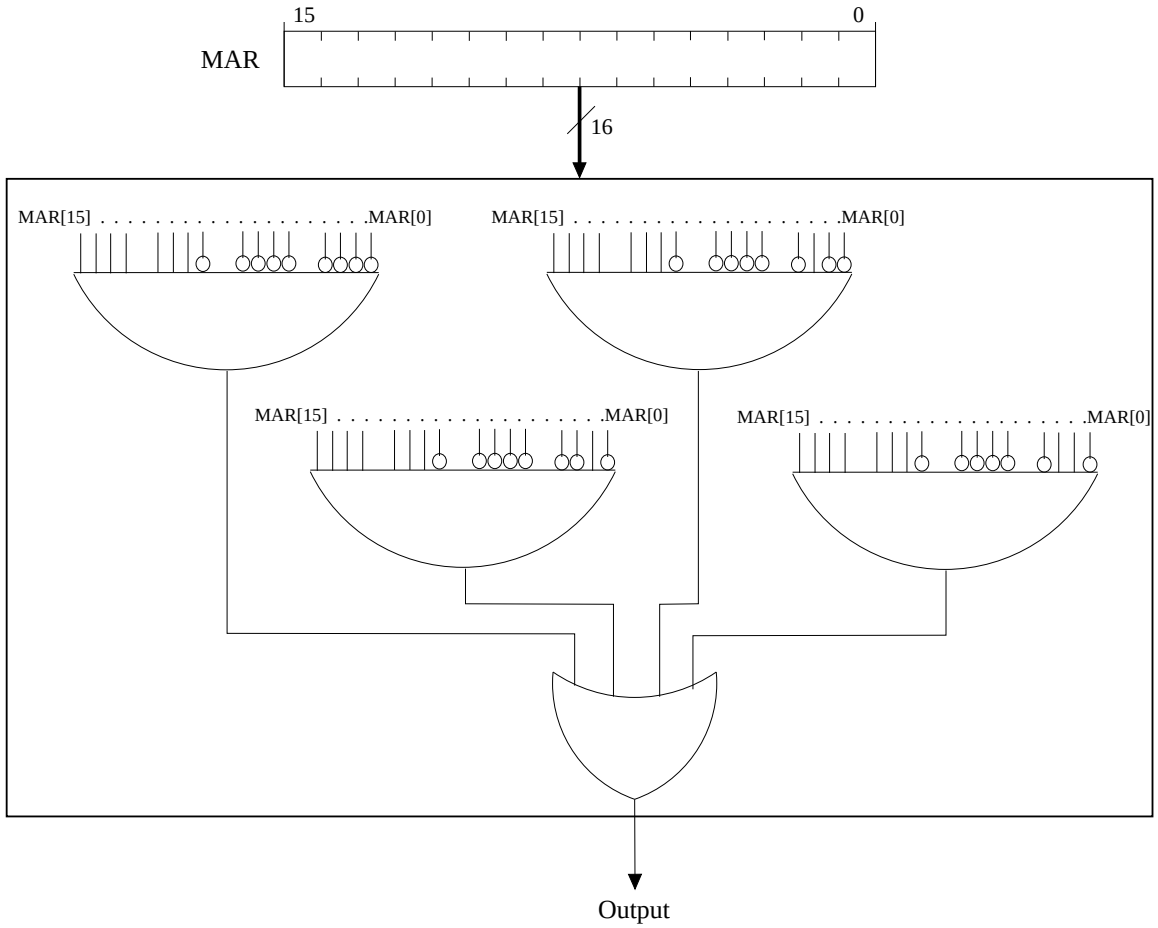
Part b (5 points): Generate the symbol table that a LC-3 assembler would create while assembling this program. You may not need all of the spaces provided.

Symbol	Address

Name:_____

Problem 4 (10 points):

The input to the following logic circuit is the 16 bits of the MAR. What information does the output provide?



Please write your answer in the box below in 25 words or fewer:

Answer:

Name:_____

Problem 5 (10 points):

The following program has been assembled and loaded into the LC-3 simulator. A breakpoint has been set on the TRAP x25 instruction. Your job is to trace the execution of the program until the breakpoint is reached. By trace we mean record the value of the PC at the beginning of each instruction in the order that they are executed. The first few have been done for you. You may not need all of the spaces provided.

Note: The instruction labeled A is at location x0100 in memory, and the instruction labeled START is at location x3000 in memory.

```
          .ORIG x0000
          .FILL x0100
          .FILL x0101
          .FILL x0102
          .FILL x0103
          .FILL x0104
          .FILL x0105
          .FILL x0106
          .BLKW x00F9
A         RET             ; LOCATION x0100
          RET
          RET
          RET
          RET
          RET
          RET
          .BLKW x2EF9
START     AND R0, R0, #0 ; LOCATION x3000
          BRz L1
          LD  R0, DATA
L1        NOT R0, R0
          BRn L2
          TRAP x05
L2        TRAP x06
          AND R0, R0, #0
          TRAP x25
DATA      .FILL x4040
          .END
```

PC Trace
x3000
x3001
x3003

Name:_____

Problem 6 (10 points):

What does the following program do?

```
          .ORIG x3000
          AND R5, R5, #0
          AND R3, R3, #0
          ADD R3, R3, #8
          LEA R0, BB
          LDR R1, R0, #1
          LDR R1, R1, #0
          ADD R2, R1, #0
AGAIN     ADD R2, R2, R2
          ADD R3, R3, #-1
          BRp AGAIN
          LDR R4, R0, #0
          AND R1, R1, R4
          NOT R1, R1
          ADD R1, R1, #1
          ADD R2, R2, R1
          BRnp NO
          ADD R5, R5, #1
NO        TRAP x25
BB        .FILL xFF00
          .FILL x4000
          .END
```

Please write your answer in the box below in 25 words or fewer:

Answer:

Name:_____

Problem 7 (20 points):

The table below shows a snapshot of the Program Counter, the 8 registers, and the condition code (CC) of the LC-3 at six different times during the execution of a program: before the program executes, after execution of instruction 1, after execution of instruction 2, after execution of instruction 3, after execution of instruction 4, and after execution of instruction 5. Fill in the missing values in the table as well as the missing parts of instructions 1, 4 and 5.

	Initial Value	After 1^{st} Instruction	After 2^{nd} Instruction	After 3^{rd} Instruction	After 4^{th} Instruction	After 5^{th} Instruction
CC	Z	N		P	N	
PC						
R0	x0000			x0000	x0000	x0000
R1	x1111	x1111	x1111	x1111	x1111	x1111
R2	x2222	x2222	x2222	x2222	x2222	x2222
R3	x3333	x3333	x3308	x3308	x3308	x3308
R4	x4444	x4444	x4444		x9FFF	x9FFF
R5	x5555	x5555	x5555	x5555	x5555	x5555
R6	x6666	x6666	x6666	x6666	x6666	x6666
R7	xFEFE		xFEF0	xFEF0	xFEF0	

Instruction 1: AND [ ]

Instruction 2: LEA R3 , #6

Instruction 3: LEA R4 , #0

Instruction 4: LD [ ] , #0

Instruction 5: [ ]