

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

EE 306, Fall, 2008

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Exam 2, November 12th, 2008

Name: Solution Sheet

Problem 1 (35 points): _____

Problem 2 (15 points): _____

Problem 3 (15 points): _____

Problem 4 (20 points): _____

Problem 5 (15 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 (35 points)

Part a (6 points): Perform Pass one of the LC-3 Assembler (create the symbol table) for the following LC-3 Assembly Language program:

```
.ORIG x4040
LD R1,A
AGAIN BRzp SKIP
ADD R0,R1,R1
TRAP x23
BRnzp AGAIN
HELP .STRINGZ "Hello, Again"
A .BLKW #10
SKIP TRAP x25
B .FILL x0200
.END
```

Symbol	Address
AGAIN	x4041
HELP	x4045
A	x4052
SKIP	x405C
B	x405D

Part b (6 points): The following assembly language program has **at most 3** bugs.

```
.ORIG x7000
LD R1,A
LD R2,B
ADD R1,R1,R1
.FILL x1842
.FILL xD07F
TRAP x25
A .BLKW x200
B .BLKW x1
.END
```

Circle the instructions that have bugs, labeling each circle 1, 2, 3, etc. In the following boxes, one box per bug, state whether the bug will show up at Assemble time, Link time, or Run time, and explain why.

1: B is too far away,
cannot calculate offset , at assemble time

2: xD07F is not a valid instruction,
detected at run time

3:

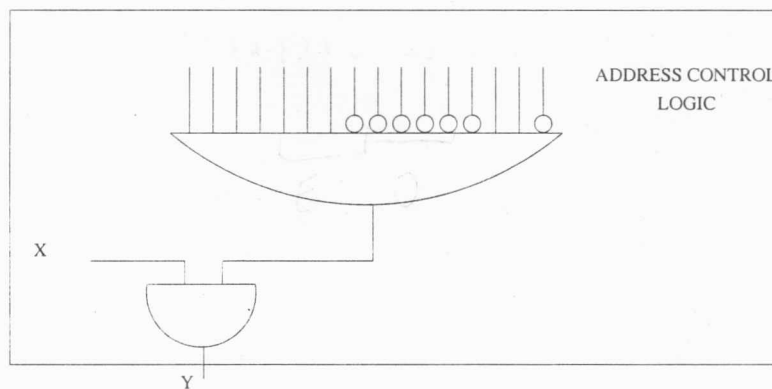
Name: _____

Part c (7 points): What does the following program do?

```
.ORIG x3000
LD R1, NUM
LDR R1, R1, #0
BRzp SKIP
NOT R1, R1
ADD R1, R1, #1
SKIP ADD R0, R1, #0
HALT
NUM .FILL x4000
.END
```

Finds absolute value of number in x4000
and put into R0

Part d (7 points): In class, we have discussed the Address control logic which generates the control signals for the Memory and the I/O device registers. We have included Figure 8.9 with this exam for your reference, if needed. Part of that logic is the 16-input AND gate and 2 input AND gate shown below.



What does the input at X signify?(be **specific**)

the R/W signal

What is the purpose of the output at Y?

If 1, write to the DDR

Name: _____

Part e (7 points): The following assembly language program is assembled and then executed.

```
.ORIG x3000
AGAIN LD R1,A
      NOT R1,R1
      ST R1,A
A     .FILL xOFDA
      BRnzp AGAIN
      .END
```

Will this program halt? If yes, explain why. If no, explain why not.

Yes, address A gets overwritten with xFOZ5 which is the HALT instruction.

Name: _____

Problem 2 (15 points)

Part a: During one clock cycle of the correct execution of a particular LC-3 instruction, the values of select signals MARMUX, ADDR1MUX, and ADDR2MUX are as shown below, and highlighted on Figure 5.18, which we have provided.

Note: The highlights shown on Figure 5-18 apply **only** to Part a and are irrelevant to Part b of this problem.

MARMUX: ADDR1MUX: ADDR2MUX:

What is the opcode of the instruction being processed?

Part b: A different opcode is LD, which in machine language is 0010. During the execution of a LD instruction, after the instruction has been decoded, one clock cycle must be devoted to loading MAR with a proper address.

Specify the values of the select signals MARMUX, ADDR1MUX and ADDR2MUX that are necessary to load MAR appropriately.

MARMUX: ADDR1MUX: ADDR2MUX:

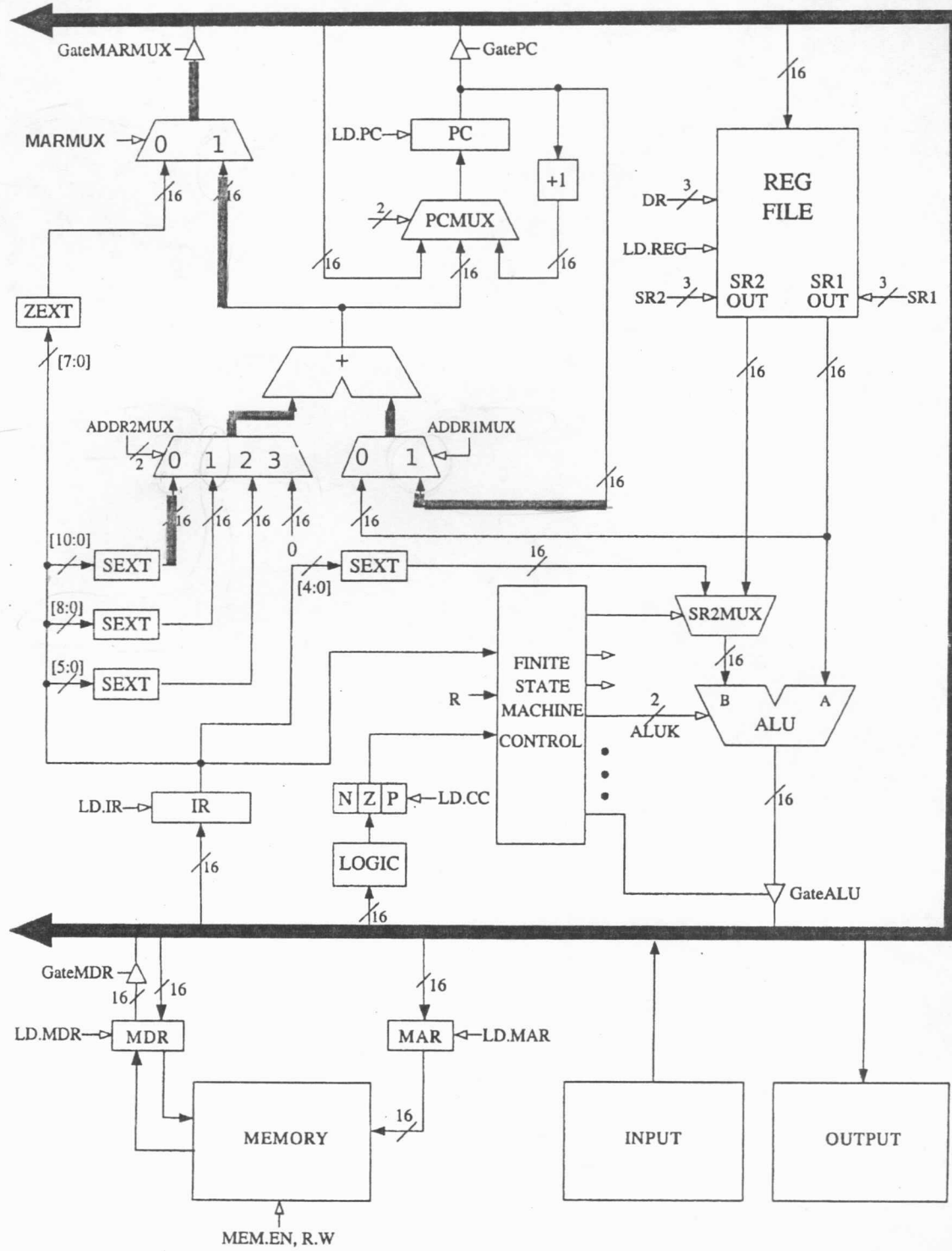


Figure 5.18 The data path of the LC-3

Name: _____

Problem 3 (15 points)

A programmer wrote the following program which was assembled and executed. Execution started with PC at x3000.

```
.ORIG x3000

LEA R0, Message
TRAP x01
TRAP x22 ; What is the output here?
TRAP x25

Message .STRINGZ "Cat in the hat."

.END
```

Assume that the Trap Vector Table includes the following entries in addition to the ones we have previously used:

Memory Address	Memory Contents
x0000	x0100
x0001	x0102
x0002	x0107
x0003	x010A

Assume further that additional trap service routines have been loaded previously in memory as specified below:

```
.ORIG x0100

LD R7, SaveR7
RET
ST R7, SaveR7
TRAP x02
AND R1, R1, #0
STR R1, R0, #3
RET
AND R1, R1, #0
STR R1, R0, #5
TRAP x00
RET
SaveR7 .BLKW #1

.END
```

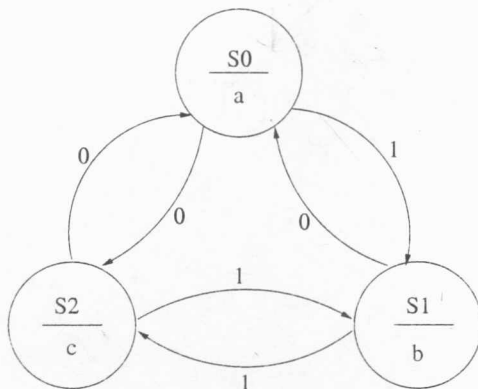
What is the result of execution of this program (in 20 words or fewer)?

outputs "Cat i" to console

Name: _____

Problem 4 (20 points)

The state machine shown below will produce an output sequence if it receives an input sequence. The initial state is S0.



For example, the input sequence 100 produces the output sequence bac.

We have written a program that simulates this state machine. Inputs are requested from the keyboard, and the corresponding outputs are shown on the screen. For example, for the input sequence shown above, the monitor would display

```
INPUT (either 0 or 1): 1
OUTPUT: b
INPUT (either 0 or 1): 0
OUTPUT: a
INPUT (either 0 or 1): 0
OUTPUT: c
```

Your job: Complete the program that simulates the state machine, by filling in each blank box with **one** missing line of LC-3 assembly language code.

Note: You can assume the person at the keyboard can type a 1 or a 0 without error (i.e., you do not have to test for wrong input).

.ORIG x3000
LEA R6, S0

Loop

LEA R0, INPUT

TRAP x22
TRAP x20 ; inputs a character
TRAP x21

LD R1, NEGASCII
ADD R0, R0, R1

ADD R6, R6, R0

LDR R6, R6, #0
LD R0, NEWLINE
TRAP x21
LEA R0, OUTPUT
TRAP x22

LDR R0, R6, #2

TRAP x21
LD R0, NEWLINE
TRAP x21
BRnzp LOOP

S0 .FILL S2
.FILL S1
.FILL x0061

S1 .FILL S0
.FILL S2
.FILL x0062

S2 .FILL S0
.FILL S1
.FILL x0063

NEGASCII .FILL xFFD0 ; the value -48
OUTPUT .STRINGZ "OUTPUT:"
INPUT .STRINGZ "INPUT (either 0 or 1):"
NEWLINE .FILL x000A

.END