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

EE 379K, Fall, 2000
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Final, December 15, 2000

Name:_____

Problem 1 (30 points):_____

Problem 2 (10 points):_____

Problem 3 (10 points):_____

Problem 4 (10 points):_____

Problem 5 (10 points):_____

Problem 6 (10 points):_____

Problem 7 (10 points):_____

Problem 8 (10 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.

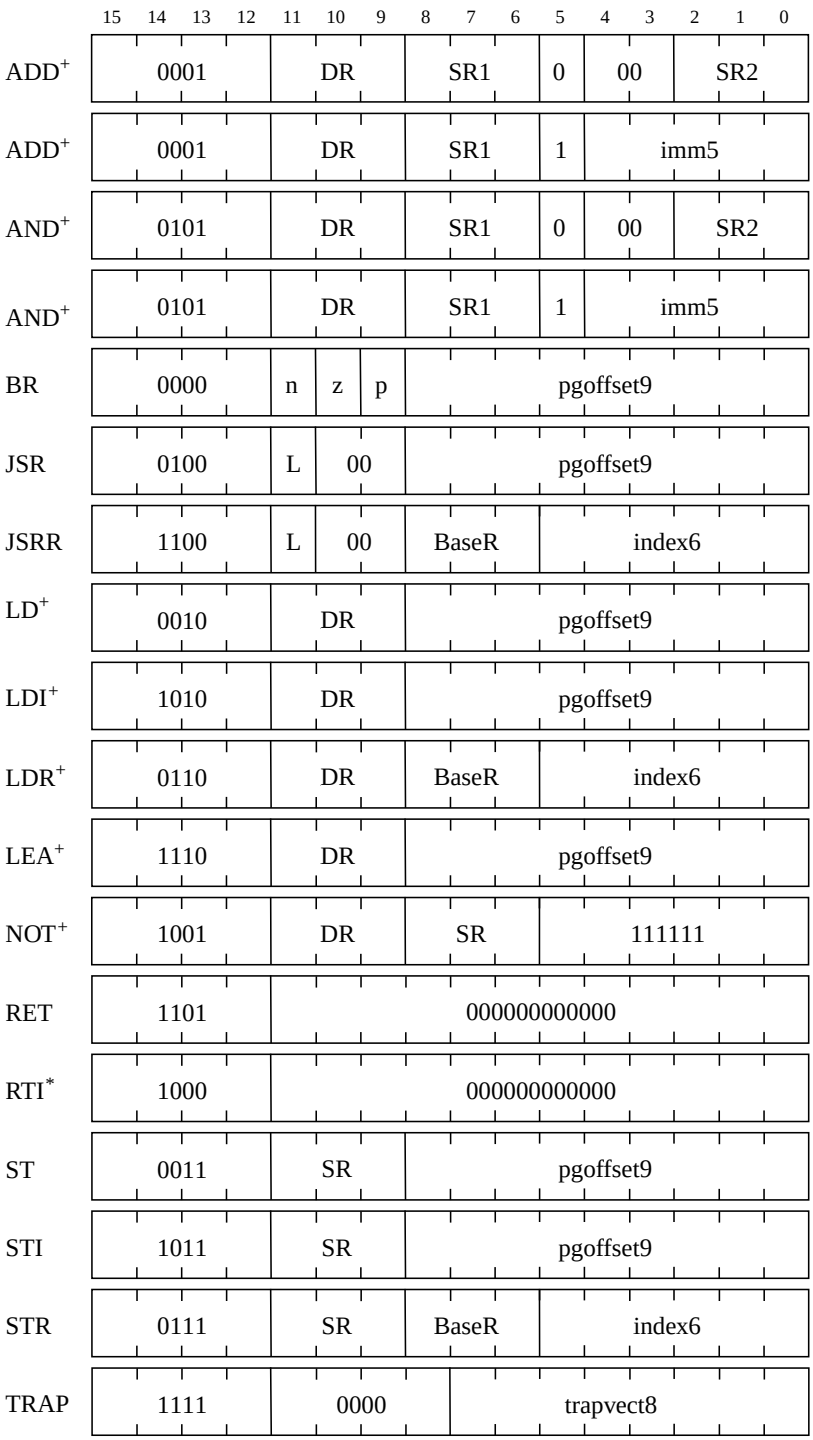
Note: Please be sure your name is recorded on each sheet of the exam.

GOOD LUCK!

(ps. Good luck with the rest of your exams, and have a great semester break.)

Useful Stuff

LC-2 ISA Reference



Name:_____

Problem 1 (30 points):

Part I (7.5 points): LC-2 instructions A and B do basically the same thing. In 10 words or fewer, what do they do?

A: 0000000101010101
B: 0001000000100000

However, they can not be used interchangeably because they do not do exactly the same thing. What is this difference? Again, in ten words.

Part II (7.5 points): The ElCheapo Computer company decided to make a poor man's LC-2, which they are calling the LC-0.5. It has 8 opcodes, 4 registers, 10 bits of address space, and 12 bits of addressibility. Otherwise, it is patterned after the LC-2, with LD and LDI instructions, for example, specified like they are in the LC-2. How many locations on a page of LC-0.5 memory? How many pages of LC-0.5 memory?

Part III (7.5 points): The PC contains x3010. The following memory locations contain values as shown:

```
x3050:  x70A2
x70A2:  x70A3
x70A3:  xFFFF
x70A4:  x123B
```

The following three instructions are then executed, causing a value to be loaded into R6. What is that value?

```
x3010  LEA R3,x50
x3011  LDR R4,R3,#0
x3012  LDR R6,R4,#0
```

We could replace the three-instruction sequence with a single instruction. What is it?

Part IV (7.5 points): An LDR instruction, located at x4011, uses R4 as its base register. The value currently in R4 is x3200. What is the largest address that this instruction can load from? Suppose we redefine the LDR offset to be sign-extended, rather than zero-extended. Then what would be the largest address that this instruction could load from? With the new definition, what would be the smallest address that this instruction could load from?

Name:_____

Problem 2 (10 points):

We have reproduced the data path of the LC-2 on the next page, highlighting three signal lines, labeled on the diagram as A, B, and C.

For each signal line, identify one LC-2 opcode that use that signal line in the processing of its corresponding instruction.

Explain what function that signal helps accomplish in that instruction.

A

Opcode:

Function:

B

Opcode:

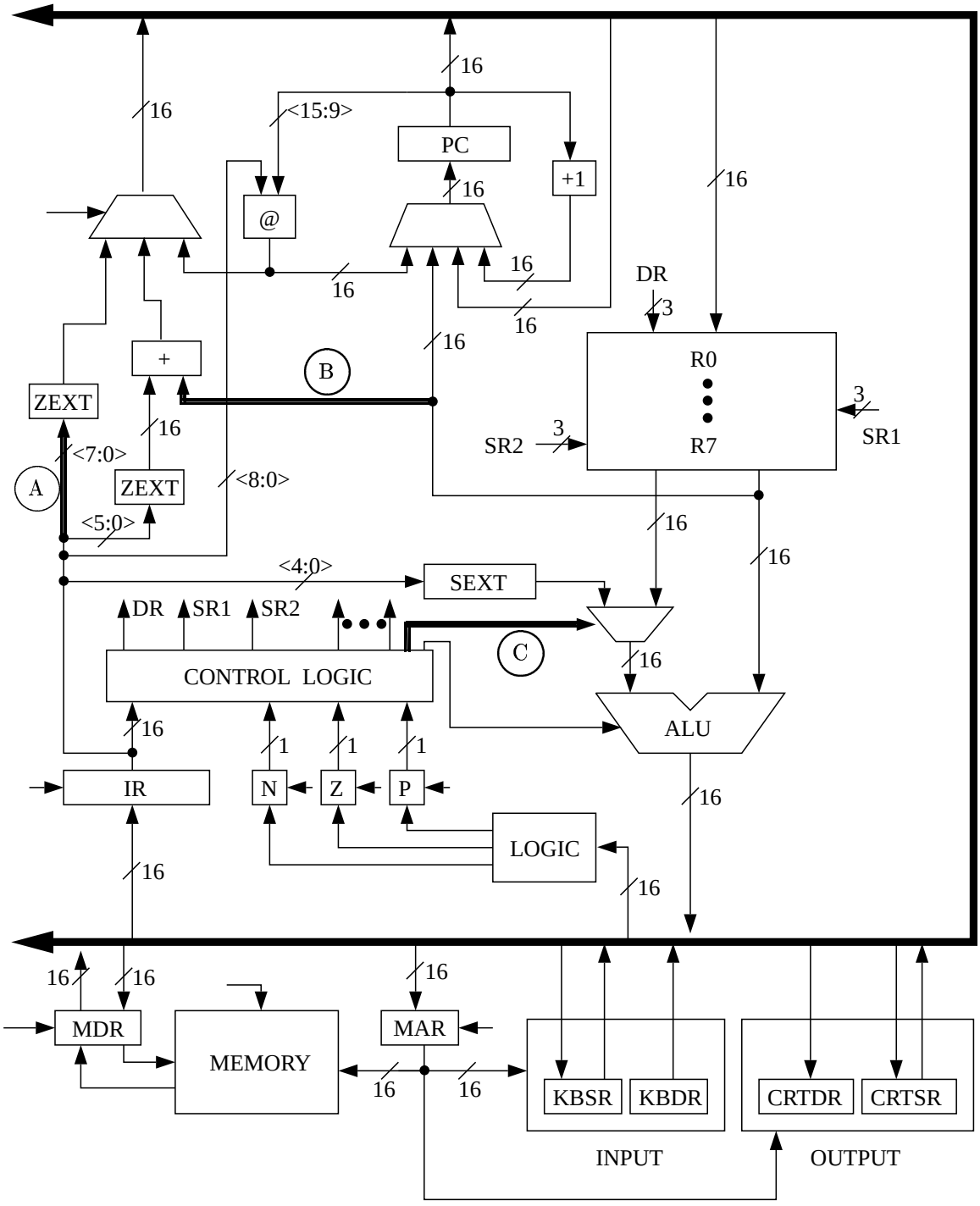
Function:

C

Opcode:

Function:

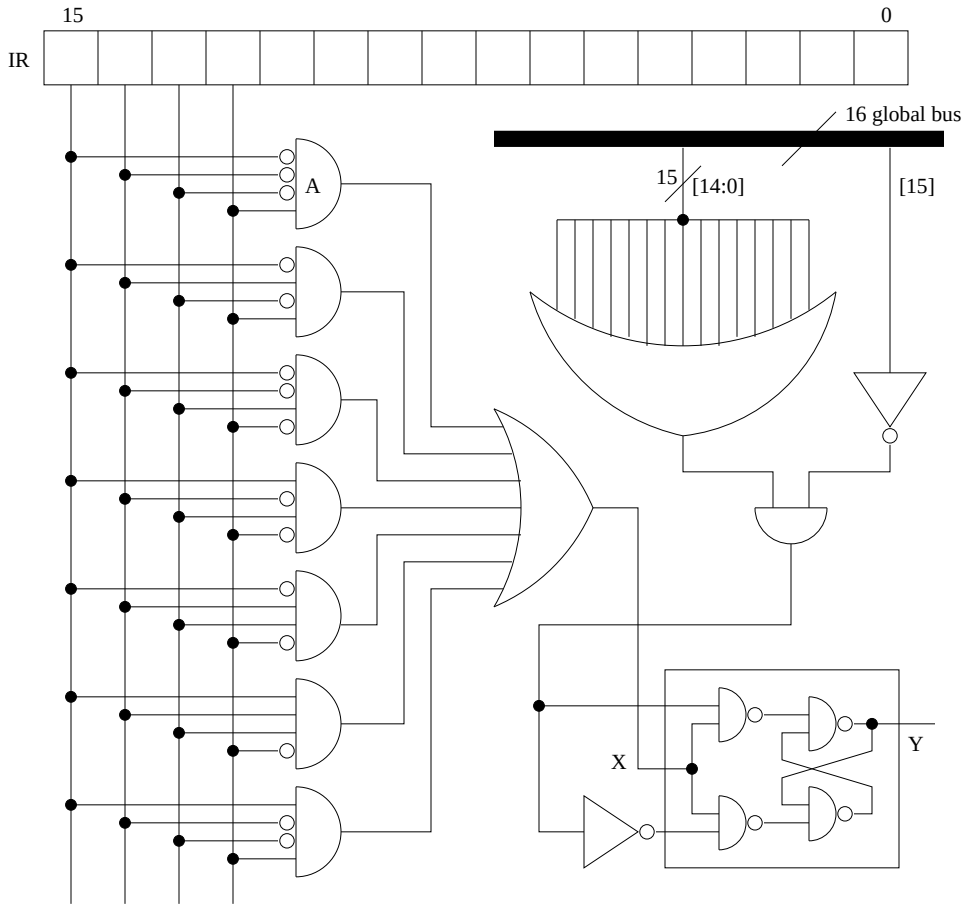
Problem 2, continued



Name:_____

Problem 3 (10 points):

A part of the implementation of the LC-2 architecture is shown below:



Part A. What information does Y provide?

Part B. The signal X is the control signal that gates the Gated D latch. What determines whether X is asserted or not? Please be specific, but brief. 20 words are more than sufficient to answer the question.

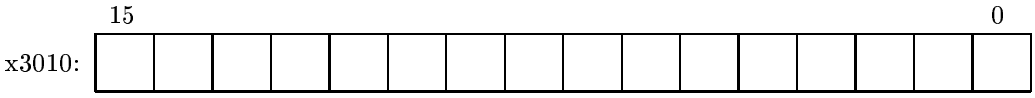
Name:_____

Problem 4 (10 points):

Shown below are the contents of registers **before** and **after** the LC-2 instruction at location x3010 is executed. Your job: identify the instruction stored in x3010. Note: There is enough information below to uniquely specify the instruction at x3010.

	Before	After
R0:	xFF1D	xFF1D
R1:	x321C	x321C
R2:	x2F11	x2F11
R3:	x5321	x5321
R4:	x331F	x331F
R5:	x1F22	x1F22
R6:	x01FF	x01FF
R7:	x341F	x3011
PC:	x3010	x3220
N :	0	0
Z :	1	1
P :	0	0

Please write your answer in the box below:



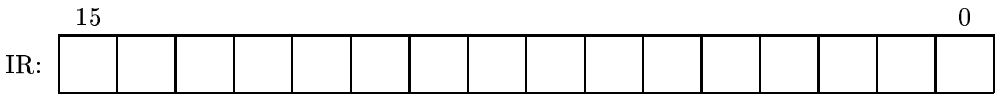
Name:_____

Problem 5 (10 points):

Suppose we define a new service routine starting at memory location x4000. This routine reads in a character and echos it to the screen. Suppose memory location x0027 contains the value x4000. The service routine is shown below.

...	
x4000	GETC
x4001	OUT
x4002	RET
...	

Identify the instruction that will invoke this routine by filling in the box below.



Will this service routine work? Circle yes or no below. Explain.

Answer: yes / no

Name:_____

Problem 6 (10 points):

What does the following program do?

```
            .ORIG   x3000
            LEA     R6, STACKBASE
            ADD     R6, R6, #-1
            LEA     R0, PROMPT
            TRAP    x22             ; PUTS
            AND     R1, R1, #0
LOOP        TRAP    x20             ; IN
            TRAP    x21
            ADD     R3, R0, x-A     ; negative of the ASCII code for "enter"
            BRz     INPUTDONE
            JSR     PUSH
            ADD     R1, R1, #1
            BRnzp   LOOP
INPUTDONE   ADD     R1, R1, #0
            BRz     DONE
LOOP2       JSR     POP
            TRAP    x21
            ADD     R1, R1, #-1
            BRp     LOOP2
DONE        TRAP    x25             ; HALT

PUSH        ADD     R6, R6, #1
            STR     R0, R6, #0
            RET

POP         LDR     R0, R6, #0
            ADD     R6, R6, #-1
            RET

PROMPT      .STRINGZ "Please enter a sentence: "
STACKBASE   .BLKW   #50
            .END
```

Please write your answer in the box below:

Answer:

Name:_____

Problem 7 (10 points):

The following LC-2 program determines whether a string is a palindrome or not. A palindrome is a string that reads the same backwards as forwards. For example, the string "racecar" is a palindrome. Suppose a string starts at memory location x4000, and terminates with the value x0, like the `.STRINGZ` that we have studied. If the string is a palindrome, the program terminates with the value 1 in R5. If not, the program terminates with the value 0 in R5. Fill in the blanks that will complete the program.

```
        .ORIG   x3000
; Step 1
        LD      R0, PTR
        ADD     R1, R0, #0
AGAIN   LDR     R2, R1, #0
        BRz     CONT
        ADD     R1, R1, #1
        BRnzp   AGAIN
CONT    _____________________
; Step 2
LOOP    LDR     R3, R0, #0
        _____________________
        NOT     R4, R4
        ADD     R4, R4, #1
        ADD     R3, R3, R4
        BRnp    NO
; Step 3
        _____________________
        _____________________
        NOT     R2, R0
        ADD     R2, R2, #1
        ADD     R2, R1, R2
        BRnz    YES
        _____________________
; Step 4
YES     AND     R5, R5, #0
        ADD     R5, R5, #1
        BRnzp   DONE
NO      AND     R5, R5, #0
DONE    HALT

PTR     .FILL   x4000
        .END
```

Name:_____

Problem 8 (10 points):

Part A. What does this program do? Ten words should do.

```
          .ORIG   x3000
          LDI     R3, A
          STI     R3, KBSR
AGAIN     LD      R0, B
          TRAP    x21
          BRnzp   AGAIN
A         .FILL   x4000
B         .FILL   x0032
KBSR      .FILL   xF400
          .END
```

Part B. Now then, recall we discussed interrupt-driven input/output, whereby an input or output device can interrupt the program that is executing.

We noted that like the 8-bit trapvector that is part of every TRAP instruction, there is an 8-bit interruptvector that is supplied to the processor along with the signal indicating that some device wishes to interrupt the normal processing.

Suppose the interruptvector for the keyboard is x34, and the contents of memory location x0034 is x1000.

The keyboard interrupt service routine is shown below:

```
          .ORIG   x1000
          LDI     R0, KBDR
          TRAP    x21
          TRAP    x25
KBDR      .FILL   xF401
          .END
```

What does the Keyboard interrupt service routine do? 10 words should be enough.

Part C. Finally, suppose the program of Part A started executing, and someone sitting at the Keyboard struck a key. What would you see on the screen?