

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

EE 379K, Fall, 2000

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Exam 2, November 15, 2000

Name: _____

Problem 1 (20 points): _____

Problem 2 (20 points): _____

Problem 3 (10 points): _____

Problem 4 (15 points): _____

Problem 5 (10 points): _____

Problem 6 (10 points): _____

Problem 7 (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 recorded on each sheet of the exam.

GOOD LUCK!

Useful Stuff, page 1

ASCII CODES

ASCII			ASCII			ASCII			ASCII		
Character	Dec	Hex	Character	Dec	Hex	Character	Dec	Hex	Character	Dec	Hex
nul	0	00	sp	32	20		64	40	'	96	60
soh	1	01	!	33	21	A	65	41	a	97	61
stx	2	02	"	34	22	B	66	42	b	98	62
etx	3	03	#	35	23	C	67	43	c	99	63
eot	4	04	\$	36	24	D	68	44	d	100	64
enq	5	05	%	37	25	E	69	45	e	101	65
ack	6	06	&	38	26	F	70	46	f	102	66
bel	7	07	'	39	27	G	71	47	g	103	67
bs	8	08	(	40	28	H	72	48	h	104	68
ht	9	09	)	41	29	I	73	49	i	105	69
lf	10	0A	*	42	2A	J	74	4A	j	106	6A
vt	11	0B	+	43	2B	K	75	4B	k	107	6B
ff	12	0C	,	44	2C	L	76	4C	l	108	6C
cr	13	0D	-	45	2D	M	77	4D	m	109	6D
so	14	0E	.	46	2E	N	78	4E	n	110	6E
si	15	0F	/	47	2F	O	79	4F	o	111	6F
dle	16	10	0	48	30	P	80	50	p	112	70
dc1	17	11	1	49	31	Q	81	51	q	113	71
dc2	18	12	2	50	32	R	82	52	r	114	72
dc3	19	13	3	51	33	S	83	53	s	115	73
dc4	20	14	4	52	34	T	84	54	t	116	74
nak	21	15	5	53	35	U	85	55	u	117	75
syn	22	16	6	54	36	V	86	56	v	118	76
etb	23	17	7	55	37	W	87	57	w	119	77
can	24	18	8	56	38	X	88	58	x	120	78
em	25	19	9	57	39	Y	89	59	y	121	79
sub	26	1A	:	58	3A	Z	90	5A	z	122	7A
esc	27	1B	;	59	3B	[	91	5B	{	123	7B
fs	28	1C	<	60	3C	\	92	5C	|	124	7C
gs	29	1D	=	61	3D	]	93	5D	}	125	7D
rs	30	1E	>	62	3E		94	5E	~	126	7E
us	31	1F	?	63	3F	-	95	5F	del	127	7F

Device register assignments

Location	I/O Register Name	I/O Register Function
xF3FC	CRT status register	Also known as CRTSR. The ready bit (bit [15]) indicates if the video device is ready to receive another character to print on the screen.
xF3FF	CRT data register	Also known as CRTDR. A character written in the low byte of this register will be displayed on the screen.
xF400	Keyboard status register	Also known as KBSR. The ready bit (bit [15]) indicates if the keyboard has received a new character.
xF401	Keyboard data register	Also known as KBDR. Bits [7:0] contain the last character typed on the keyboard.
xF402	Machine control register	Also known as MCR. Bit [15] is the clock enable bit. When cleared, instruction processing stops.

Useful Stuff, page 2

LC-2 ISA Reference

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ADD ⁺	0001			DR			SR1			0	00		SR2			
ADD ⁺	0001			DR			SR1			1	imm5					
AND ⁺	0101			DR			SR1			0	00		SR2			
AND ⁺	0101			DR			SR1			1	imm5					
BR	0000			n	z	p	pgoffset9									
JSR	0100			L	00		pgoffset9									
JSRR	1100			L	00		BaseR			index6						
LD ⁺	0010			DR			pgoffset9									
LDI ⁺	1010			DR			pgoffset9									
LDR ⁺	0110			DR			BaseR			index6						
LEA ⁺	1110			DR			pgoffset9									
NOT ⁺	1001			DR			SR			111111						
RET	1101			000000000000												
RTI [*]	1000			000000000000												
ST	0011			SR			pgoffset9									
STI	1011			SR			pgoffset9									
STR	0111			SR			BaseR			index6						
TRAP	1111			0000			trapvect8									

Name: _____

Problem 1 (20 points):

Part I (7 points): An LC-2 Load instruction specifies the address xF401. How do we know whether to load from the KBDR or from memory location xF401?

Part II (7 points): The program counter contains the address of a LDR instruction. In order for the LC-2 to process that instruction, how many memory accesses must be made? (Processing includes all phases of the instruction cycle.) Repeat this task for STI, LEA, and TRAP.

LDR: _____ memory accesses

STI: _____ memory accesses

LEA: _____ memory accesses

TRAP: _____ memory accesses

Part III (6 points): An LC-2 assembly language program contains the instruction:

ASCII LD R1, ASCII

The symbol table entry for ASCII is x4F08. If this instruction is executed during the running of the program, what will be contained in R1 immediately after the instruction is executed?



Name: _____

Problem 2 (20 points):

Part a (10 points): Assemble the following program into LC-2 machine code. Show each machine instruction in its corresponding memory location. You may not need to use all of the entries.

```

        .ORIG  x3000
        LD     R0,ASCII
        LD     R1,NEG
AGAIN   LDI    R2,CRTSR
        BRzp  AGAIN
        STI   R0,CRTDR
        ADD   R0,R0,#1
        ADD   R2,R0,R1
        BRnp  AGAIN
        HALT
ASCII   .FILL  x0030
NEG     .FILL  xFFC6  ; -x003A
CRTSR   .FILL  xF3FC
CRTDR   .FILL  xF3FF
        .END

```

Address	Instruction

Symbol	Address

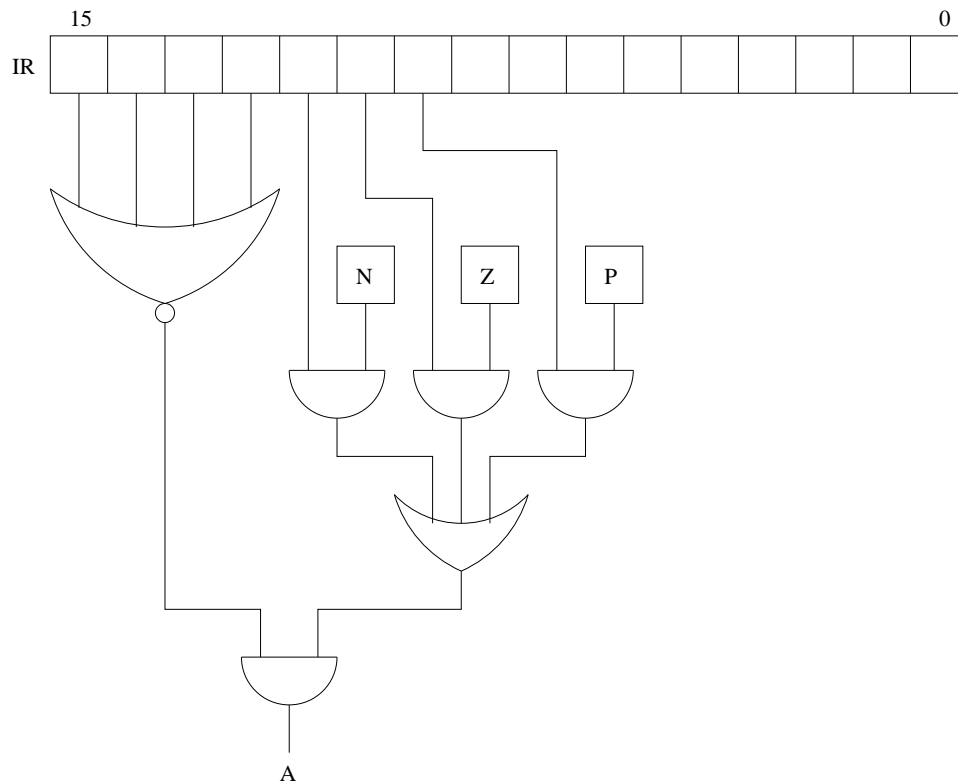
Part b (10 points): What does the program do? Please express your answer in NO MORE THAN ten words? [A correct answer containing more than ten words will have one point deducted for each word over ten! (So a correct answer of more than 20 words will do your grade more harm than leaving the answer blank.)]

Answer:

Name: _____

Problem 3 (10 points):

The logic diagram below shows part of the control structure of the LC-2 machine. What is the purpose of the signal labeled A?



Name: _____

Problem 4 (15 points):

Shown below are the contents of memory and 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:	x3308	x3308
R1:	x2035	x2035
R2:	x3e1f	x3e1f
R3:	x33ff	x33ff
R4:	x2c7c	x2c7c
R5:	xf4a2	xfef
R6:	x5220	x5220
R7:	xe373	xe373
...		
x3400:	x3001	x3001
x3401:	x7a00	x7a00
x3402:	x7a2b	x7a2b
x3403:	x31ba	x31ba
x3404:	xa700	xa700
x3405:	xf011	xf011
x3406:	x2003	x2003
x3407:	xc100	xc100
x3408:	xfef	xfef
...		

Please write your answer in the box below:

15																			0
x3010:																			

Name: _____

Problem 5 (10 points):

The following program is supposed to print the number 5 on the screen. It does not work. Why? Answer in no more than ten words, please.

```
        .ORIG    x3000
        JSR     A
        OUT
        BRnzp   DONE
A       AND     R0,R0,#0
        ADD     R0,R0,#5
        JSR     B
        RET
DONE    HALT
ASCII  .FILL    x0030
B       LD      R1,ASCII
        ADD     R0,R0,R1
        RET
        .END
```


Name: _____

Problem 6 (10 points):

The two code sequences shown below are assembled separately. There are two bugs that will be caught at assemble time or at link time. Circle each bug; label them “bug 1” and “bug 2”. In the box provided, describe why the bug will cause an error, and identify whether it will be detected at assemble time or link time.

```
.EXTERNAL SQRT
.ORIG x3000
LD R0, VALUE
JSR SQRT
ST R0, DEST
HALT
VALUE .FILL x30000
DEST .FILL x0025
.END

.ORIG x3200
SQRT ADD R0, R0, #0
; code to perform square
; root function and
; return the result in R0
RET
.END
```

Bug 1:

Bug 2:

Name: _____

Problem 7 (15 points):

Shown below is a partially constructed program. The program asks the user his/her name and stores the sentence "Hello, name" as a string starting from the memory location indicated by the symbol HELLO. The program then outputs that sentence to the screen. The program assumes that the user has finished entering his/her name when he/she presses the enter key, whose ASCII code is x0A. The name is restricted to be not more than 25 characters.

Assuming that the user enters Onur followed by a carriage return when prompted to enter his/her name, the output of the program looks exactly like:

```
Please enter your name: Onur
Hello, Onur
```

Insert the four missing instructions to complete the job.

```

        .ORIG x3000
        LEA  R1,HELLO
AGAIN   LDR  R2,R1,#0
        BRz  NEXT
        ADD  R1,R1,#1
        BRnzp AGAIN
NEXT    LEA  R0,PROMPT
        TRAP x22          ; PUTS
        _____
AGAIN2  TRAP x20          ; GETC
        TRAP x21          ; OUT
        ADD  R2,R0,R3
        BRz  CONT
        _____
        BRnzp AGAIN2
CONT    AND  R2,R2,#0
        _____
        LEA  R0,HELLO
        TRAP x22          ; PUTS
        TRAP x25          ; HALT
NEGENTER .FILL xFFF6      ; -x0A
PROMPT  .STRINGZ "Please enter your name: "
HELLO   .STRINGZ "Hello, "
        .BLKW #25
        .END
```