CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING
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Midterm Examination 4
In Class (50 minutes)
Friday, December 14, 2007
Weight: 15%

CLOSED BOOK, NOTE, CALCULATOR, PHONE, & COMPUTER.

The exam in two-sided and has **TEN** pages, including two blank pages and a copy of the ***Standard ASCII Table***, some ***Trap Service Routines*** description and the ***LC-3 Instruction Set handout*** on the final page (please feel free to detach this final page, but insert it into your exam when you turn it in).

Plan your time carefully, since some problems are longer than others.

NAME: _____

SECTION:_____

ID# _____

Problem Number	Maximum Points	Points Awarded
1	4	
2	2	
3	7	
4	8	
5	7	
6	2	
Total	30	

Problem 1 (4 points): Short Answers

a. What is the problem with using the string NOT as a label in an LC-3 assembly language program?

b. What single instruction is equivalent to the following two LC-3 instructions?

```
LEA R7, #1
JMP R2, #0
```

c. The LC-3 assembly process is done in two complete passes through the entire assembly language program. What is the objective of the first pass?

d. What is the purpose of .ORIG pseudo-op?

Problem 2 (2 points): Memory-Mapped I/O

Suppose an ISA has a 16-bit address space. All addresses wherein bits[15:12] = 1111 are allocated to I/O device registers.

a. What is the minimum address of I/O device registers?

b. What is the maximum address of I/O device registers?

Problem 3 (7 points): Two-Pass Assembly Process

An assembly language LC-3 program is given below:

```
1            .ORIG x3000
2       ONE  LD   R2, A
3            ADD  R1, R1, R2
4       TWO  LD   R2, B
5            ADD  R1, R1, R2
6            ST   R1, SUM
7            TRAP x25
8       A    .FILL x1111
9       B    .FILL x2222
10      C    .FILL x3333
11           .END
```

a. Fill in the symbol table for the program:

Symbol	Address
ONE	x3000

b. Assuming that both passes of the assembler were to execute, write the binary word (machine language instruction) that would be generated by the assembler for the first instruction of the program.

c. The programmer intended the program to add the values stored in memory locations A and B, and store the result into memory. There are two errors in the code. For each, describe the error and indicate whether it will be detected at assembly time or at run time.

Problem 4 (8 points): Trap Routines and Save/Restore Problem

Suppose we define a new service routine starting at memory location x4200. This routine reads in a character and echoes it to the screen. Suppose memory location x0062 contains the value x4200. The service routine is shown below.

```
01              .ORIG  x4200
02              ST     R0,    SAVERA
03              ST     ___,   SAVERB
04              GETC
05              OUT
06              LD     R0,    SAVERA
07              LD     ___,   SAVERB
08              RET
09  SAVERA      .FILL  x0000
10  SAVERB      .FILL  x0000
```

a. Fill the blanks in the above program.

b. Identify the instruction that will invoke this routine.

c. Line 10 is the RET instruction, will a BR (Unconditional branch) instruction work instead? Why or why not?

d. What do instructions in line 02 and 06 do? Will the service routine work without these two lines? Why or why not?

Problem 5 (7 points): I/O Basic

An assembly language LC-3 program is given below:

```
        .ORIG x3000
        LD    R0, ASCII
        LD    R1, NEG
LOOP    LDI   R2, DSR
        BRzp  LOOP
        STI   R0, DDR
        ADD   R0, R0, #1
        ADD   R3, R0, R1
        BRnz  LOOP
        HALT
ASCII   .FILL x0047
NEG     .FILL xFFB3
DSR     .FILL xFE04       ; Address of DSR
DDR     .FILL xFE06       ; Address of DDR
        .END
```

a. What does this program do?

b. What is the purpose of the Display Status Register (DSR)?

c. What problem could occur if the display hardware does not check the DSR before writing to the DDR?

d. Circle the correct combination that describes this program?
   a. Memory mapped and interrupt driven
   b. Special opcode for I/O and interrupt driven

c. Memory mapped and polling
d. Special opcode for I/O and polling

Problem 6 (2 points): Professional Ethics

Regarding the assigned reading "RFID Inside" on RFID implants, do you support RFID implants? Why or why not? Give two different reasons to support your position.

Scratch Sheet 1 (in case you need additional space for some of your answers)

ASCII Table

Character	*Hex*	*Character*	*Hex*	*Character*	*Hex*	*Character*	*Hex*
nul	00	sp	20	@	40	`	60
soh	01	!	21	A	41	a	61
stx	02	"	22	B	42	b	62
etx	03	#	23	C	43	c	63
eot	04	$	24	D	44	d	64
enq	05	%	25	E	45	e	65
ack	06	&	26	F	46	f	66
bel	07	'	27	G	47	g	67
bs	08	(	28	H	48	h	68
ht	09	)	29	I	49	i	69
lf	0A	*	2A	J	4A	j	6A
vt	0B	+	2B	K	4B	k	6B
ff	0C	,	2C	L	4C	l	6C
cr	0D	-	2D	M	4D	m	6D
so	0E	.	2E	N	4E	n	6E
si	0F	/	2F	O	4F	o	6F
dle	10	0	30	P	50	p	70
dc1	11	1	31	Q	51	q	71
dc2	12	2	32	R	52	r	72
dc3	13	3	33	S	53	s	73
dc4	14	4	34	T	54	t	74
nak	15	5	35	U	55	u	75
syn	16	6	36	V	56	v	76
etb	17	7	37	W	57	w	77
can	18	8	38	X	58	x	78
em	19	9	39	Y	59	y	79
sub	1A	:	3A	Z	5A	z	7A
esc	1B	;	3B	[	5B	{	7B
fs	1C	<	3C	\	5C	|	7C
gs	1D	=	3D	]	5D	}	7D
rs	1E	>	3E	^	5E	~	7E
us	1F	?	3F	_	5F	del	7F

Trap Service Routines

Trap Vector	Assembler Name	Description
x20	GETC	Read a single character from the keyboard. The Character is not echoed onto the console. Its ASCII code is copied into R0. The high eight bits of R0 are cleared.
x21	OUT	Write a character in R0[7:0] to the console display.
…	…	…
x25	HALT	Halt execution and print a message on the console.

LC-3 Instruction Set (Entered by Mark D. Hill on 03/14/2007; last update 03/15/2007)

PC': incremented PC. setcc(): set condition codes N, Z, and P. mem[A]:memory contents at address A. SEXT(immediate): sign-extend immediate to 16 bits. ZEXT(immediate): zero-extend immediate to 16 bits. Page 2 has an ASCII character table.