CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN—MADISON

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Midterm Examination 1

In Class (50 minutes)

Friday, February 7, 2014

Weight: 17.5%

NO: BOOK(S), NOTE(S), OR CALCULATORS OF ANY SORT.

The exam has **nine** pages. **Circle your final answers**. Plan your time carefully since some problems are longer than others. You **must turn in the pages 1-8**. Use the blank sides of the exam for scratch work.

LAST NAME: ______________________________

FIRST NAME: ______________________________

ID# ______________________________

Problem	Maximum Points	Points Earned
1	2	
2	1	
3	2	
4	2	
5	6	
6	3	
7	4	
8	4	
9	2	
10	4	
Bonus Question	2	
Total	30	

Problem 1 **(2 Points)**

Label the following items/terms according to their level of abstraction relative to one another. Label the most abstract term as 1 and least abstract as 6.

	Code in High level language (C/C++/Java)
	Instruction Set Architecture (ISA)
	Problem Statement / Application
	Micro Architecture
	Algorithm to solve problem
	Transistors (CMOS or NMOS)

Problem 2 **(1 Point)**

Explain why natural languages cannot be used as programming languages?

Problem 3 **(2 Points)**

Assume that we had a "black box," which takes two numbers as inputs and outputs their sum, as shown in Figure 1(a). Also assume that we had another box capable of multiplying two numbers together, as shown in Figure 1(b). We can connect these boxes together to compute p × (m + n), as shown in Figure 1(c).

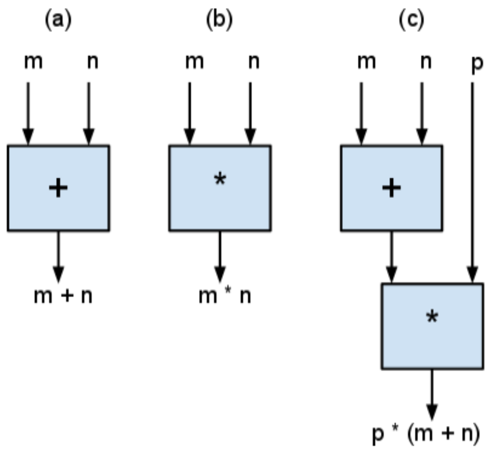

Fig 1. "Black boxes" capable of (a) Addition, (b) Multiplication and (c) A combination of both

Now, assume we have unlimited number of these boxes (i.e., the ones shown in Fig 1(a) and 1(b)). Show how to connect them together to compute (m * n * p) + 5

Problem 4 **(2 Points)**

In 1900, assume that we need 5-bits (from 00000 to 11111) to uniquely represent everyone living in Madison. Also assume that the population of Madison at present is 10 times the population in 1900. What is the minimum number of bits required to uniquely represent everyone presently living in Madison?

Problem 5 **(6 Points)**

Using **8 bits** to represent each number, write the representations of 18, -18 in signed magnitude, 1's complement and 2's complement notations.

Number	Signed Magnitude	1's complement	2's complement
18			
-18			

Problem 6 **(3 Points)**

Fill in the table below with the largest and smallest decimal numbers that can be represented with:

a) 5-bit unsigned number
b) 5-bit signed magnitude number
c) 5-bit 2's complement number

(Note: -2 is smaller than -1)

Representation	Smallest Decimal Number that can be represented using this representation	Largest Decimal Number that can be represented using this representation
5-bit unsigned number		
5-bit signed magnitude number		
5-bit 2's complement number		

Problem 7 **(4 Points)**

Perform binary arithmetic for the following pairs of 8-bit 2's complement numbers. Write your result in binary.

```
           10101001
a)       + 00111100
          ----------
```

```
           00010000
b)       - 11100010
          ----------
```

Problem 8 **(4 Points)**

Perform the specified logical operations on the following 16-bit numbers expressed in hexadecimal representation. Express your result in **hexadecimal** (base 16).

a) NOT(xCDEF)

b) xCDEF OR xF123

Problem 9 **(2 Points)**

Represent the decimal 3.5 in fixed point notation.

Problem 10 **(4 points)**

Convert the decimal value -12.125 into its IEEE single-precision floating point representation. Write your answer in **hexadecimal.**

The bits for the IEEE single-precision floating point number are allocated as follows:

Sign (1 bit)	Exponent (8 bits)	Fraction (23 bits)

where $N = (-1)^{Sign} \times 1.Fraction \times 2^{Exponent-127}$

Bonus Question: **(2 Points)**

Convert the ASCII string "Se7en!" to its hexadecimal representation. Only represent the characters within the quotation marks and assume it is null terminated. **Hint: See ASCII to hexadecimal table on page 9 of the Exam.**

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	‘ *(Apostr.)*	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	, *(Comma)*	2C	L	4C	l	6C
cr	0D	-	2D	M	4D	m	6D
so	0E	. *(Period)*	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	_ *(Undrscre)*	5F	del	7F