CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN—MADISON

Prof. Gurindar S. Sohi

TAs Ryan Johnson, Ramachandran Syamkumar, and Maheswaran Venkatachalam

Midterm Examination 1

In Class (50 minutes)

Friday, February 12, 2010

Weight: 17.5%

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

The exam has **four** two-sided pages. **Circle your final answers.**

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

NAME: _____

SECTION: _____

ID# _____

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

Problem 1 (4 points)

a) What is the greatest magnitude negative number that can be represented in *signed magnitude* representation using 7 bits? Express your answer as a decimal number.

$-2^{7-1} + 1 =$ **-63**

b) What is the largest positive number that can be represented as a *two's complement* integer using 7 bits? Express your answer as a decimal number.

$2^{7-1} - 1 =$ **63**

Problem 2 (2 points)

Compute **(1110 AND 0111) OR (NOT 0101)**

1110 AND 0111 = 0110

NOT 0101 = 1010

Answer = 0110 OR 1010 = **1110**

Problem 3 (4 points)

Consider the quad number system (base 4) where only the digits 0-3 are legal.

(a) What is the maximum unsigned decimal value that one can represent with 3 quad digits?

Answer = $4^n - 1 = 4^3 - 1 =$ **63**

(b) What is the maximum unsigned decimal value that one can represent with *n* quad digits (Hint: your answer should be a function of *n*) ?

Similar to a binary number system where the answer would be $2^n - 1$, here the answer is **$4^n - 1$**.

Problem 4 (4 points)

Consider the 8-bit binary bit pattern **1010 1010**. What is its decimal (base ten) value if the bit pattern is interpreted as:

(a) An unsigned integer?

2 + 8 + 32 + 128 = **170**

(b) A two's complement integer?

Two's complement of the given number = 0101 0101 + 1 = 0101 0110

Answer = **-86**

Problem 5 (6 points)

(a) Add the following 5-bit two's complement binary numbers: **10101 + 11101**. Express your answer in 5-bit two's complement. Please indicate if there was an overflow.

Sum = 110010**;** Ignoring the overflowing bit, Answer = **10010**

No overflow (since carry into MSB is equal to carry out of MSB)

(b) Add the following 5-bit two's complement binary numbers: **00111 + 01010**. Express your answer in 5-bit two's complement. Please indicate if there was an overflow.

Sum = **10001**

Overflow (since carry into MSB is not equal to carry out of MSB)

Problem 6 (4 points)

(a) Convert the ASCII characters **T%a** into binary. (See attached ASCII table.)

T = **0101 0100**

% = **0010 0101**

a = **0110 0001**

(b) Convert the binary value **0110 0100 0100 0100** into an ASCII string.

dD

Problem 7 (4 points)

(a) What is the base ten (decimal) value represented by binary **011.101** ?

3.625

(b) The bits for an IEEE floating point number are allocated as follows:

sign (1 bit)	exponent (8 bits)	fraction (23 bits)

where $N = (-1)^S$ x 1.fraction x $2^{\text{exponent-127}}$

Convert **1 01111110 10000000000000000000000** to decimal.

Sign = 1; Exponent = 126; Mantissa = 0.5

Answer = $-1.5*2^{-1}$ = **-0.75**

Problem 8 (2 points)

Give an example of an **integer** that **can** be represented in *floating point format (32-bit IEEE 754 format)*, but **cannot** be represented as a *32-bit two's complement integer*.

2^{32}

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

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