

CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN—MADISON

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Midterm Examination 1

In Class (50 minutes)

Friday, September 28, 2012

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 1-7.**

LAST NAME: _____

FIRST NAME: _____

ID# _____

Problem	Maximum Points	Points Earned
1	1	
2	2	
3	4	
4	3	
5	2	
6	2	
7	3	
8	2	
9	3	
10	1	
11	2	
12	1	
13	4	
Total	30	

Problem 1: An image is represented by a collection of pixels. Consider an image in which each pixel can be only one of 3 different shades. What is the number of bits I would need to store an image which contains 1024 pixels?

(1 Point)

Minimum number of bits to represent 3 shades = 2 bits

So for 1024 pixels, number of bits = $1024 \times 2 = 2048$ bits

Problem 2: Consider the number **27** in an octal number system (base 8). What is its representation in decimal?

(2 Points)

$$(27)_8 = 2 \times 8^1 + 7 \times 8^0 = 16 + 7 = (23)_{10}$$

Problem 3: Let $A = 5 \frac{3}{4}$ and $B = 3 \frac{5}{8}$. Convert them into their fixed point binary fraction form (use 8 bits, with 5 bits for the integer part and 3 bits for the fraction part) and then perform the following operation: $A - B$. Show your result both as a fixed point binary fraction and as a decimal fraction. **(4 Points)**

$$A = 0101.110$$

$$B = 0011.101$$

$$-B = 1100.011$$

$$A - B = A + (-B) = 0010.001 = 2.125$$

Problem 4: Show the result of performing the following logic operations on **X = 0xA8** and **Y = 0x0D**: (Express your answer in hexadecimal)
(NOT Y) AND (X OR Y) **(3 Points)**

X = 10101000

Y = 00001101

(NOT Y) AND (X OR Y) = 11110010 AND 10101101

= 10100000 = 0xA0

Problem 5: Consider a 16 bit binary number represented as 1011010010110100, with the right-most bit being bit 0, and the left-most bit being bit 15. I am interested in carrying out a bit-wise logical operation to extract the bits in the following bit positions: 2, 5, 9, 10 and 14. What mask should I use to get those interesting bits? Which logical operation would I use? **(2 Points)**

Mask = 0100011000100100

Logical operation to use is AND.

Problem 6: Convert the following binary code into an ASCII string (see attached ASCII table): **01000101 01100001 01010011 01111001** **(2 Points)**

= 0x 45 61 53 79 = E a S y

Problem 7: Convert the two ASCII strings “We” and “uS” into 16-bit binary strings (without the quotes; use 8 bits per character of the ASCII string). Now suppose that the resulting binary bits were 16-bit unsigned binary numbers, add these two binary strings. Show the result in binary. (See attached ASCII table.) **(3 Points)**

We = 0x5765 = 0101011101100101

uS = 0x7553 = 0111010101010011

Sum = 1100110010111000

Problem 8: What is the decimal equivalent of the following 32-bit IEEE floating point number: **01000001010100000000000000000000** **(2 Points)**

0 10000010 101000000000000000000000 = $(-1)^0 \times 1.625 \times 2^{(130-127)} = 13$

Problem 9: Add the following two 6-bit 2’s complement binary numbers:

101101 + 101010

Is there an overflow? Explain why or why not. If there is an overflow, what could I do to mitigate this problem? **(3 Points)**

Result = 1 | 010111

There is overflow, since we get a positive number on adding two negative numbers (or since there is a carry-out of the MSB and no carry-in to the MSB).

The problem can be mitigated by using more number of bits in the representation of the numbers.

Problem 10: How many different microarchitectures could exist for a single ISA? **(1 Point)**

- a) None
- b) 1
- c) 2
- d) **There is no limit**

Problem 11: Put the following items/terms in order according to their level of abstraction relative to one another, label the most abstract 1 and least abstract 5. **(2 Points)**

3	Code in High level language
5	Micro Architecture
1	Application
2	Algorithm to solve problem
4	ISA

Problem 12: Which of the following are specified by an ISA **(1 Point)**

- (i) Data Type
 - (ii) Addressing
 - (iii) Microarchitecture
-
- a) **i & ii**
 - b) i & iii
 - c) ii & iii
 - d) i, ii & iii

Problem 13: Say we have a "black box" which takes two numbers as input and outputs their sum (see Figure 1(a)). Say we have another box capable of multiplying two numbers together (see Figure 1(b)). We can connect these boxes together to calculate $p \times (m + n)$ (see Figure 1(c)). Assume we have an unlimited number of these boxes. Show how to connect them together to calculate: **(4 Points)**

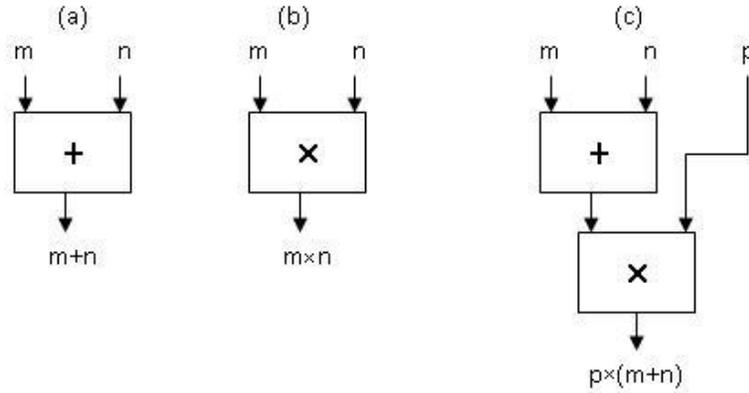
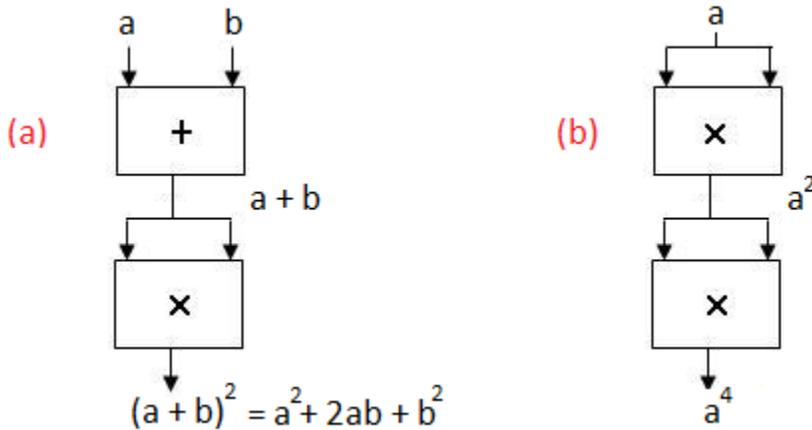


Figure 1

a) $a^2 + 2ab + b^2$ (Try to do this with a minimum number of boxes)

b) a^4



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

Extra page for hand written work, if needed. This page is not required and will NOT affect your grade. You don't even need to hand this page in.