

NAME: _____

STUDENT #: _____

1. Fill in the rest of the table.

Decimal (unsigned)	Binary (%)	Hexadecimal (\$)
42	% 00101010	\$ 2A
$\begin{array}{r} 105 \\ 201 \\ 155 \\ 092 \end{array}$	% 01101001 % 11001001 % 10011011 % 01011100	\$ 69 \$ C9 \$ 9B \$ 5C
250	% 11111010	\$ FA

6

2. Perform each of the operations in the table below. Express the answer in binary, decimal, and hexadecimal, and compute the flags Z, N, Vsub, Vadd, B and C. The grayed-out cells **will not be marked**.

Operation on 8-bit values	Results								
	Binary	Decimal	Hex	Z	N	Vsub	Vadd	B	C
a. \$FA + \$08	%		\$ 02	0	0				1
b. \$FA + \$06	%		\$ 00	1	0				1
c. \$FA + \$07	%		\$ 01	0	0				1
d. \$FA + \$09	%		\$ 03	0	0				1
e. \$69 + \$3C	%		\$ A5	0	1		1		
f. \$59 + \$3C	%		\$ 95	0	1		1		
g. \$49 + \$3C	%		\$ 85	0	1		1		
h. \$39 + \$4C	%		\$ 85	0	1		1		
i. \$89 - \$3D	%		\$ 4C	0	0	1			
j. \$90 - \$39	%		\$ 57	0	0	1			
k. \$89 - \$0D	%		\$ 7C	0	0	1			
l. \$90 - \$0D	%		\$ 83	0	1	0			
m. \$22 - \$23	%		\$ FF	0	1			1	
n. \$23 - \$32	%		\$ F1	0	1			1	
o. \$22 - \$33	%		\$ EF	0	1			1	
p. \$32 - \$32	%		\$ 00	1	0			0	

4
1 mark for whole row correct

3. Suppose you are using 8-bit signed values to compute something important, and -128 is subtracted from 0. Suppose you are using 8-bit signed values to compute something important, and -128 is added to 0. Suppose you are using 8-bit signed values to compute something important, and -127 is subtracted from -1. Suppose you are using 8-bit signed values to compute something important, and -128 is added to 0. Does this produce an overflow to be concerned about? Explain in plain English, not logic equations.

Yes
No
No
No

3

1: Yes or No
2: For explanation - see section 202

4. With 4-bit arithmetic, the equations for C and Vsub are $C = a_3b_3 + a_3\bar{r}_3 + b_3\bar{r}_3$ and $V_{sub} = a_7\bar{b}_7\bar{r}_7 + a_7\bar{b}_7r_7$. Give an example where adding two 4-bit values results in both C=0 (ALSO: C=1) and Vsub=1. What is the correct way to interpret the Vsub=1 result (keep in mind that your example uses addition)?

3

2: example (1 for only a3, b3, r3; 1 for 4-bit values)
1: interpretation of Vsub: during an addition, Vsub is meaningless and should be ignored.

5. Use the Computational Datapath worksheet on the back to perform each of the operations below. For each operation, write out the sequence of μ-ops required in RTN. Treat each operation as if it is a stand-alone operation that does not depend upon the previous one. Do not rely upon the registers having any particular initial values. Change only the register or memory location specified. There may be multiple solutions.

7
(2+5)

- a. Mem[1] ← R2
- b. R2 ← R1 + Mem[2]
- ba. R2 ← Mem[1]
- d. R3 ← 2 + Mem[R1]
- ca. Mem[1] ← R1
- f. R3 ← 2 + Mem[R1]
- da. R1 ← Mem[1]
- h. R1 ← R3 + Mem[2]

5

NAME: _____

STUDENT #: _____

1. Fill in the rest of the table.

Decimal (unsigned)	Binary (%)	Hexadecimal (\$)
42	% 00101010	\$2A
$\begin{array}{r} 181 \\ 201 \\ 155 \\ 092 \end{array}$	% 10110101 % 11001001 % 10011011 % 01011100	\$B5 \$C9 \$9B \$5C
250	% 11111010	\$FA

2. Perform each of the operations in the table below. Express the answer in binary, decimal, and hexadecimal, and compute the flags Z, N, Vsub, Vadd, B and C. The grayed-out cells will not be marked.

4
1 mark for whole row correct

Operation on 8-bit values	Results								
	Binary	Decimal	Hex	Z	N	Vsub	Vadd	B	C
a. \$FB + \$06	%		\$61	0	0				1
b. \$FA + \$06	%		\$00	1	0				1
c. \$FB + \$05	%		\$00	1	0				1
d. \$FA + \$05	%		\$FF	0	1				0
e. \$69 + \$8C	%		\$F5	0	1		0		
f. \$59 + \$8C	%		\$E5	0	1		0		
g. \$39 + \$3C	%		\$75	0	0		0		
h. \$39 + \$2C	%		\$65	0	0		0		
i. \$09 - \$0D	%		\$FC	0	0		0		
j. \$0D - \$09	%		\$04	0	0		0		
k. \$F9 - \$0D	%		\$EC	0	1		0		
l. \$09 - \$FD	%		\$0C	0	0		0		
m. \$23 - \$32	%		\$F1	0	1				1
n. \$33 - \$22	%		\$11	0	0				0
o. \$22 - \$33	%		\$EF	0	1				1
p. \$32 - \$23	%		\$0F	0	0				0

3. Suppose you are using 8-bit signed values to compute something important, and -128 is subtracted from 0. Suppose you are using 8-bit signed values to compute something important, and -128 is added to 0. Suppose you are using 8-bit signed values to compute something important, and -127 is subtracted from -1. Suppose you are using 8-bit signed values to compute something important, and -127 is added to -1. Does this produce an overflow to be concerned about? Explain in plain English, not logic equations.

Yes
No
No
No

1: Yes or No

2: For explanation

Yes: +127 is the largest 8-bit signed value, so +128 overflows to -128
No: 8-bit signed values range from -128 to +127

4. With 4-bit arithmetic, the logic equations for C and B are $C = a_3b_3 + a_3r_3 + b_3r_3$ and $B = a_3b_3 + b_3r_3 + a_3r_3$.

3 Give an example where adding two 4-bit values results in both C=1 and B=1. What is the correct way to interpret the B=1 result (keep in mind that your example uses addition)?

2: example (1 for only a_3, b_3, r_3 ; 1 for 4-bit values)

1: interpretation of ~~B~~ B: during an addition, B is meaningless and should be ignored

A ₃	B ₃	R ₃
0	1	0
1	1	1

5. Use the Computational Datapath worksheet on the back to perform each of the operations below. For each operation, write out the sequence of μ -ops required in RTN. Treat each operation as if it is a stand-alone operation that does not depend upon the previous one. Do not rely upon the registers having any particular initial values. Change only the register or memory location specified. There may be multiple solutions.

7
(2+5)

- a. Mem[1] \leftarrow R2
- b. R2 \leftarrow R1 + Mem[2]
- c. R2 \leftarrow Mem[1]
- d. R3 \leftarrow 2 + Mem[R1]
- e. Mem[1] \leftarrow R1
- f. R3 \leftarrow 2 + Mem[R1]
- g. R1 \leftarrow Mem[1]
- h. R1 \leftarrow R3 + Mem[2]

Section 201

4/ $C = a_3 b_3 + a_3 \bar{r}_3 + b_3 \bar{r}_3$

$V_{sub} = a_3 \bar{b}_3 \bar{r}_3 + \bar{a}_3 b_3 r_3$

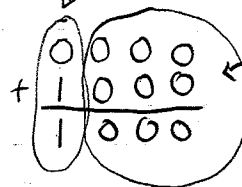
find example where $C=0$ and $V_{sub}=1$ by writing out a truth table for a_3, b_3, r_3

a_3	b_3	r_3	C	V_{sub}
0	0	0	0	0
0	0	1	0	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	1
1	0	1	0	0
1	1	0	1	0
1	1	1	1	0

$\leftarrow C=0$ and $V_{sub}=1 \Rightarrow \bar{a}_3 b_3 r_3$

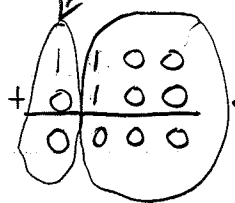
$\leftarrow C=1$ and $V_{sub}=1 \Rightarrow a_3 \bar{b}_3 \bar{r}_3$

Example for $C=0, V_{sub}=1$:



rest of 4-bit values must agree with column 3 result

$C=1, V_{sub}=1$:



Section 202

4/ $a_3 \ b_3 \ r_3 \ | \ C \ B = \bar{a}_3 b_3 + b_3 r_3 + \bar{a}_3 r_3$

a_3	b_3	r_3	C	B
0	0	0	0	0
0	0	1	0	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	1	0
1	1	1	1	1

either $\bar{a}_3 b_3 \bar{r}_3$ or $a_3 b_3 r_3$

