Key to Midterm Exam S1
Computer Architecture

Answer on the worksheet **Duration: 1 hr. 30 min.**

Last name: ..... First name: ..... Group: .....

Exercise 1 (4 points)

1. Simplify the following expressions. Give each result in a power-of-two form. Write down the result only (do not show any calculation).

Expression	Result
$\frac{32^8 \cdot 8^4 \cdot 128^7}{((1{,}999+49)^3 \cdot 16^{-5})^5}$	$\mathbf{2^{36}}$
$\frac{((8{,}192 \cdot 16^{11})^5 \cdot 65{,}536^{-8})^3}{(32^{-5} \cdot (500+12))^{-5} \cdot 4{,}096}$	$\mathbf{2^{379}}$

2. How many bits do the following values contain? **Use a power-of-two notation**. Write down the result only (do not show any calculation).
   - 128 Mib = **2^{27} bits**
   - 2 KiB = **2^{14} bits**

3. How many bytes do the following values contain? Use binary prefixes (Ki, Mi or Gi). **Choose the most appropriate prefix so that the integer numerical value will be as small as possible**. Write down the result only (do not show any calculation).
   - 128 Gib = **16 GiB**
   - 2^{31} bits = **256 MiB**

Exercise 2 (4 points)

Convert the following numbers from the source form into the destination form. Do not write down the result in a fraction or a power form (e.g. write down 0.25 and not ¼ or 2^{-2}). Write down the result only (do not show any calculation).

Number to Convert	Source Form	Destination Form	Result
11110001.0001	Binary	Decimal	**241.0625**
3FA.1	Hexadecimal	Decimal	**1,018.0625**
125.4	Decimal	Hexadecimal (2 digits after the point)	**7D.66**
52.0625	Decimal	Binary	**110100.0001**
6142.153	Base 8	Hexadecimal	**C62.358**
7.25	Decimal	Base 5 (3 digits after the point)	**12.111**
67	Base 9	Base 3	**2021**
1110101011.111011	Binary	Hexadecimal	**3AB.EC**

Exercise 3 (4 points)

Perform the following 8-bit binary operations (the two operands and the result are 8 bits wide). Then, convert the result into unsigned and signed decimal values. If an overflow occurs, write down 'ERROR' instead of the decimal value. Write down the result only (do not show any calculation).

Operation	Binary Result	Decimal Value	
		Unsigned	Signed
01100110 - 10011011	11001011	**ERROR**	**ERROR**
10001100 + 01111110	00001010	**ERROR**	**10**
01111011 + 10000011	11111110	**254**	**-2**
10010011 - 10001101	00000110	**6**	**6**

Exercise 4 (4 points)

Perform the operations below. **Show all calculations.**

Base 2

		1	0	1	1	0	1	1	0	1
	–		1	0	1	0	0	1	1	0
			1	**1**	**0**	**0**	**0**	**1**	**1**	**1**

Base 16

		F	8	C	C	
+		3	2	B	B	
	1	**2**	**B**	**8**	**7**	

Base 2

	1	0	0	0	1	1	1	1	1	1	0	1	
-		1	1	0	1				**1**	**0**	**1**	**1**	
			1	0	0	1	1						
		-		1	1	0	1						
					1	1	0	1					
				-	1	1	0	1					
								0					

Base 8

		3	7	3	4	
+		4	7	2	5	
	1	**0**	**6**	**6**	**1**	

Exercise 5 (4 points)

1. A memory has 2000_{16} addresses.

   How many address lines does this memory have? **13**

   Assuming that the lowest address is 0_{16}, what is the highest address (in hexadecimal)? **$1FFF_{16}$**

2. A memory has 11 address lines.

   How many addresses are available (in hexadecimal)? **800_{16}**

   Assuming that the lowest address is 0_{16}, what is the highest address (in hexadecimal)? **$7FF_{16}$**

3. The memory space of a microprocessor is made up of 4 memory devices (**M1**, **M2**, **M3** and **M4**). **M1** and **M2** both have 2000_{16} addresses. **M3** and **M4** both have 11 address lines. **M1** should be located in the lowest part of the memory space, followed by **M2**, **M3** and **M4**. The lowest address of the memory space is 0.

   Complete the table below (in hexadecimal):

M1	Lowest Address	**0000_{16}**
	Highest Address	**$1FFF_{16}$**
M2	Lowest Address	**2000_{16}**
	Highest Address	**$3FFF_{16}$**

M3	Lowest Address	**4000_{16}**
	Highest Address	**$47FF_{16}$**
M4	Lowest Address	**4800_{16}**
	Highest Address	**$47FF_{16}$**

   What is the minimum number of address lines required by the microprocessor? **15**

Feel free to use the blank space below if you need to: