Key to Midterm Exam S1
Computer Architecture

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

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

Exercise 1 (2 points)

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
$\frac{64^4 \cdot 16^5 \cdot 8^{-8}}{(256^{-3} \cdot 32^{16})^4}$	$\mathbf{2^{-204}}$
$\frac{((65536 \cdot 32^{-3})^3 \cdot 2048^{10})^5}{(64^{-7} \cdot 1024)^{-7} \cdot 256}$	$\mathbf{2^{333}}$

Exercise 2 (3 points)

1. How many bytes do the following values contain? **Use a power-of-two notation**. Write down the result only (do not show any calculation).
   - 256 GiB = **2^{38} bytes**
   - 128 Kib = **2^{14} bytes**
   - 32 Mib = **2^{22} bytes**

2. How many bits 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).
   - 2^{15} bits = **32 Kib**
   - 4 MiB = **32 Mib**
   - 2^{35} bytes = **256 Gib**

Exercise 3 (5 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
10111001.01101	Binary	Decimal	**185.40625**
CE.68	Hexadecimal	Decimal	**206.40625**
88.88	Decimal	Hexadecimal (2 digits after the point)	**58.E1**
105.40625	Decimal	Binary	**110 1001.01101**
151.32	Base 8	Binary	**110 1001.01101**
151.32	Base 8	Hexadecimal	**69.68**
151.32	Hexadecimal	Base 8	**521.144**
59.27	Decimal	Base 7 (3 digits after the point)	**113.161**
32	Base 4	Base 5	**24**
101110101.01011	Binary	Hexadecimal	**175.58**

Exercise 4 (2 points)

Part 1: Encoding unsigned integers

1. Let us consider the following 8-bit addition: **250 + 10**
   The two operands and the result are 8 bits wide. Write down the base-10 representation of the 8-bit result.

250 + 10 = **4**

2. Let us consider the following 8-bit subtraction: **4 – 10**
   The two operands and the result are 8 bits wide. Write down the base-10 representation of the 8-bit result.

4 – 10 = **250**

Part 2: Encoding <u>signed</u> integers

3. Let us consider the following 8-bit addition: **120 + 10**
   The two operands and the result are 8 bits wide. Write down the base-10 representation of the 8-bit result.

120 + 10 = **-126**

4. Let us consider the following 8-bit subtraction: **–126 – 10**
   The two operands and the result are 8 bits wide. Write down the base-10 representation of the 8-bit result.

–126 – 10 = **120**

<u>Exercise 5</u> (4 points)

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

Base 2

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

Base 16

		9	C	A	8	
+		B	F	C	E	
	1	**5**	**C**	**7**	**6**	

Base 2

	1	0	1	0	1	0	0	0	1	1	0	0	
		1	0	0	1	0			**1**	**1**	**1**	**0**	
				1	1	0	0						
							0	0					
								0					

Base 8

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

Exercise 6 (4 points)

1. A memory has 4000_{16} addresses.

   How many address lines does this memory have? **14**

   Assuming that the lowest address is 0_{16}, what is the highest address (in hexadecimal)? **$3FFF_{16}$**

2. A memory has 10 address lines.

   How many addresses are available (in hexadecimal)? **400_{16}**

   Assuming that the lowest address is 0_{16}, what is the highest address (in hexadecimal)? **$3FF_{16}$**

3. The memory space of a microprocessor is made up of 4 memory devices (**M1**, **M2**, **M3** and **M4**). **M1** and **M2** both have 4000_{16} addresses. **M3** and **M4** both have 10 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	**$3FFF_{16}$**
M2	Lowest Address	**4000_{16}**
	Highest Address	**$7FFF_{16}$**

M3	Lowest Address	**8000_{16}**
	Highest Address	**$83FF_{16}$**
M4	Lowest Address	**8400_{16}**
	Highest Address	**$87FF_{16}$**

   What is the minimum number of address lines required by the microprocessor? **16**

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