

# Key to Midterm Exam S1

## Computer Architecture

Answer on the worksheet

Duration: 1 hr 30 min.

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

**Exercise 1 (3 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
$\frac{64^5 \cdot 4^7 \cdot 4^6}{(512^{-4} \cdot 128^8)^{-3}}$	$2^{116}$
$\frac{(32^5 \cdot 1024^{-4}) \cdot (180+76)^{-7}}{(2^{-10} \cdot (2^{10} - 2^9))^3 \cdot 1024^{-4}}$	$2^{-28}$
$\frac{((2048 \cdot 8^{13})^3 \cdot 16384^{-8})^6}{(8^{-12} \cdot 128)^{-14} \cdot 32768}$	$2^{-193}$

**Exercise 2 (3 points)**

1. How many bits do the following values contain? Use a power-of-two notation. Write down the result only (do not show any calculation).

• 2 Kib =  $2^{11}$  bits

• 128 KiB =  $2^{20}$  bits

• 512 GiB =  $2^{42}$  bits

•

2. 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).

• 32 Mib =  $4$  MiB

•  $2^{20}$  bits =  $128$  KiB

•  $2^{21}$  bytes =  $2$  MiB

**Exercise 3 (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  $\frac{1}{4}$  or  $2^{-2}$ ). Write down the result only (do not show any calculation).

Number to Convert	Source Form	Destination Form	Result
11101101.1011	Binary	Decimal	<b>237.6875</b>
23F.B	Hexadecimal	Decimal	<b>575.6875</b>
1027.5	Decimal	Hexadecimal	<b>403.8</b>
221.3125	Decimal	Binary	<b>11011101.0101</b>
335.24	Base 8	Hexadecimal	<b>DD.5</b>
105.34	Decimal	Base 7 (3 digits after the point)	<b>210.224</b>
36	Base 9	Base 3	<b>1020</b>
1011001101.01101	Binary	Hexadecimal	<b>2CD.68</b>

**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 signed 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.

$$120 + 10 = \mathbf{-126}$$

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.

$$\mathbf{-126 - 10 = 120}$$

**Exercise 5 (4 points)**

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

Base 2										
		1	0	0	1	1	0	1	1	0
	–		1	0	0	1	1	1	1	1
			1	0	0	1	0	1	1	1

**Exercise 6 (4 points)**

1. A memory has
- $8000_{16}$
- addresses.

How many address lines does this memory have? **15**Assuming that the lowest address is  $0_{16}$ , what is the highest address (in hexadecimal)?  **$7FFF_{16}$** 

2. A memory has 12 address lines.

How many addresses are available (in hexadecimal)?  **$1000_{16}$** Assuming that the lowest address is  $0_{16}$ , what is the highest address (in hexadecimal)?  **$FFF_{16}$** 

3. The memory space of a microprocessor is made up of 4 memory devices (
- M1**
- ,
- M2**
- ,
- M3**
- and
- M4**
- ).
- M1**
- and
- M2**
- both have
- $8000_{16}$
- addresses.
- M3**
- and
- M4**
- both have 12 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):

<b>M1</b>	Lowest Address	<b><math>0000_{16}</math></b>
	Highest Address	<b><math>7FFF_{16}</math></b>
<b>M2</b>	Lowest Address	<b><math>8000_{16}</math></b>
	Highest Address	<b><math>FFFF_{16}</math></b>

<b>M3</b>	Lowest Address	<b><math>10000_{16}</math></b>
	Highest Address	<b><math>10FFF_{16}</math></b>
<b>M4</b>	Lowest Address	<b><math>11000_{16}</math></b>
	Highest Address	<b><math>11FFF_{16}</math></b>

What is the minimum number of address lines required by the microprocessor? **17**

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