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
$\frac{64^5 \cdot 8^6 \cdot 16^3}{(256^{-5} \cdot 128^2)^{-4}}$	$\mathbf{2^{-44}}$
$\frac{(8^8 \cdot 512^{-7}) \cdot (11000+5384)^{-9}}{(16^{-5} \cdot (2^{20} - 2^{19}))^6 \cdot 256^{-7}}$	$\mathbf{2^{-103}}$
$\frac{((8192 \cdot 32^7)^4 \cdot 32768^{-4})^6}{(8^{-9} \cdot 1024)^{-9} \cdot 4096}$	$\mathbf{2^{627}}$

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).
   - 16 Mib = **2^{24} bits**
   - 512 MiB = **2^{32} bits**
   - 64 KiB = **2^{19} 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).
   - 64 Mib = **8 MiB**
   - 2^{33} bits = **1 GiB**
   - 2^{25} bytes = **32 MiB**

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
10111001.0101	Binary	Decimal	**185.3125**
E8.5	Hexadecimal	Decimal	**232.3125**
167.7	Decimal	Hexadecimal (2 digits after the point)	**A7.B3**
92.3125	Decimal	Binary	**101 1100.0101**
13.25	Base 8	Binary	**1011.010101**
2705.14	Base 8	Hexadecimal	**5C5.3**
4BC.23	Hexadecimal	Base 8	**2274.106**
80.25	Decimal	Base 5 (2 digits after the point)	**310.11**
40	Base 9	Base 3	**1100**
100110011.10011	Binary	Hexadecimal	**133.98**

Exercise 4 (5 points)

1. Work out the value of the base *b* so that the identity below is true. **Show all calculations.**

$22_b \times 25_b = 50A_b$ **b > 10**

$(2b + 2)(2b + 5) = 5b^2 + 10$
$4b^2 + 10b + 4b + 10 = 5b^2 + 10$
$b^2 – 14b = 0$
$b(b – 14) = 0$

~~$b1$~~ = 0
b2 = 14

b = 14

1. Work out the value of the base *b* so that the identity below is true. **Show all calculations.**

$12_b \times 25_b = 50A_b$ **b > 10**

$(b + 2)(2b + 5) = 5b^2 + 10$
$2b^2 + 5b + 4b + 10 = 5b^2 + 10$
$3b^2 – 9b = 0$
$b^2 – 3b = 0$
$b(b – 3) = 0$

~~$b1$~~ = 0
~~$b2$~~ = 3

There is no solution.

2. According to the identity below, determine the relation between the *a* and *b* bases and work out their smallest values. Justify your answer. **Show all calculations.**

$208_a = 808_b$ **a > 8** and **b > 8**

$2a^2 + 8 = 8b^2+8$
$2a^2 = 8b^2$
$a^2 = 4b^2$
a = 2b

b_{min} = 9
a_{min} = 18

Exercise 5 (4 points)

1. In terms of *n*, how many *n*-bit unsigned integers can be encoded?

2^n

2. In terms of *n*, how many *n*-bit signed integers can be encoded?

2^n

3. In terms of *n*, what is the largest *n*-bit unsigned integer that can be encoded?

2^n-1

4. In terms of *n*, what is the largest *n*-bit signed integer that can be encoded?

$2^{n-1}-1$

5. In terms of *n*, what is the smallest *n*-bit signed integer that can be encoded?

-2^{n-1}

6. The one's complement inverts each bit of a word. **Answer true or false.**

True

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