Namn:_____

Datorarkitektur, 2010

Tentamen 2010-03-19

Instructions:

- Make sure that your exam is not missing any sheets, then write your full name on the front.
- Write your answers in the space provided below the problem. If you make a mess, clearly indicate your final answer.
- The exam has a maximum score of 60 points plus 3 possible bonus points.
- The aproximate limits for grades on this exam are:
  - To pass (grade E): 35 points.
  - For grade D: 40 points.
  - For grade C: 45 points.
  - For grade B: 50 points.
  - For grade A: 55 points.
- You're allowed to bring five sheets of paper with any text to this exam but no computer, calulator, telephone etc.

Problem 1. (20 points):

Give short explanations (in Swedish or English) of the following computer systems concepts.

- Pointer (Pekare)

- ISA

- Latch

- Branch prediction

- Loop unrolling

Problem 2. (10 points):

Consider a **4-bit** two's complement representation. Fill in the empty boxes in the following table:

Number	Decimal Representation	Binary Representation
Zero	0	
—	-1	
—	-5	
—		0110
—		1010
TMax		
TMin		
TMax+TMax		
TMin−1		
0−TMax		

Problem 3. (12 points):

Consider the following 12-bit floating point representation based on the IEEE floating point format:

- There is a sign bit in the most significant bit.
- The next five bits are the exponent. The exponent bias is 15.
- The last six bits are the significand.

We consider the floating point format to encode numbers in a form:

$$(-1)^s \times m \times 2^E$$

where m is the *mantissa*, E is the exponent, and s is the sign bit.
Fill in the table below for the following numbers, with the following instructions for each column:

Hex: The 3 hexadecimal digits describing the encoded form.

s**:** The sign bit.

E**:** The integer value of the exponent.

m**:** The fractional value of the mantissa. This should be a number of the form x or x/y, where x is an integer, and y is an integral power of 2. Examples include: 0, 3/16, and 1/64.

As an example, to represent the number $7/2$, we would have $s = 0$, $m = 7/4$, and $E = 1$. Our number would therefore have an exponent field of `0x10` (decimal value $15 + 1 = 16$) and a significand field `0x30` (binary 110000_2), giving a hex representation `430`.

Description	Hex	s	E	m
-1				
31/8				
Smallest value > 2				

Problem 4. (10 points):

Condider the following assembly code for a C `for` loop:

```
loop:
    pushl %ebp
    xorl %eax, %eax
    movl %esp, %ebp
    movl 8(%ebp), %ecx
    testl %ecx, %ecx
    jle .L4
    movl $1, %edx
.L5:
    imull %edx, %eax
    incl %edx
    incl %eax
    cmpl %edx, %ecx
    jge .L5
    addl %eax, %eax
.L4:
    popl %ebp
    ret
```

Based on the assembly code above, fill in the blanks below in its corresponding C source code. (Note: you may only use the symbolic variables `x`, `i`, and `result` in your expressions below — *do not use register names.*)

```
int loop(int x) {
    int i, result;
    result = 0;

    for (____________________; ____________________; i++) {

        ____________________________;

        ____________________________;
    }

    result = _____________;
    return result;
}
```

Problem 5. (8 points):

Give at least two reasons why performance may start to degrade when you add more pipeline stages to a CPU.