Computer Architecture and Programming Languages
Jacobs University Bremen
Arsenij Percov

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# Homework 8

## Problem 8.1

**Solution:**

(*i*) 25/32 ==
$0.78125 \times 2 = 1.5625(1)$
$0.5625 \times 2 = 1.125(1)$
$0.125 \times 2 = 1.25(0)$
$0.25 \times 2 = 0.5(0)$
$0.5 \times 2 = 1.0(1)$
$0.11001 = 1.1001 \times 2^{-1}$
$exp = -1 \Rightarrow 127 - 1 = 126_{10} = 01111110_2$

| sign | exponent | fraction |
|---|---|---|
| 0 | 01111110 | 10010000000000000000000 |

(*ii*) 27.3515625 =
$27 \div 2 = 13(1)$
$13 \div 2 = 6(1)$
$6 \div 2 = 3(0)$
$3 \div 2 = 1(1)$
$1 \div 2 = 0(1)$
$\Rightarrow 11011 = 1.1011 \times 2^4$
$\Rightarrow exp = 4 + 127 = 131_{10} = 10000011_2$
$0.3515625 \times 2 = 0.703125(0)$
$0.703125 \times 2 = 1.40625(1)$
$0.40625 \times 2 = 0.8125(0)$
$0.8125 \times 2 = 1.625(1)$
$0.625 \times 2 = 1.25(1)$
$0.25 \times 2 = 0.5(0)$
$0.5 \times 2 = 1.0(1)$

| sign | exponent | fraction |
|---|---|---|
| 0 | 10000011 | 01011010000000000000000 |

## Problem 8.2

**Solution:**
True, False, False, False, False.

## Problem 8.3

**Solution:**
000000 10000 10101 01011 00000 100000
Opcode: 000000 = 0 (Addition and subtraction)
Rs: 10000 = 16
Rt: 10101 = 16 + 4 + 1 = 21
Rd: 01011 = 8 + 2 + 1 = 11
Shamt: 00000
Funct: 100000 = 32
add $t3 $s0 $s5

## Problem 8.4

**Solution:**
a) 26
b) Since all addresses are multiples of 4, last two bits are 00, so we shift the address to the right, then we have 4 highest order bits are coming from the high- order four bits in the PC. We use jal instead of j.

## Problem 8.5

**Solution:**

P1 = $0.6 \times 1 + 0.1 \times 2 + 0.1 \times 3 + 0.1 \times 4 + 0.1 \times 3 = 1.8$
P2 = $0.6 \times 2 + 0.1 \times 2 + 0.1 \times 2 + 0.1 \times 4 + 0.1 \times 4 = 2.4$
CPU time 1 = $1.8 \times 13/4 = 5.85$
CPU time 2 = $2.4 \times 14/6 = 5.6$
5.85/5.6 = 1.044642
P2 4.46462 percent faster

## Problem 8.6

**Solution:**
x - number of executions
CPU time for P1 : $(1 * 2k + 3 * k + 3 * k + 4 * k + 2 * k)/2 = 7k$
CPU time for P2 : $(2 * 2k + 3 * k + 2 * k + 3 * k + 3 * k)/4 = 3.75k$
7.5k/3.75k = 7.5/3.75 = 1.866666667
P2 86 percent faster.