COMPUTER ARCHITECTURE   **Exam 25. 1. 2017**

1. Particular program is translated into machine instructions on two different computers C1 and C2:

Measurement	Computer C1	Computer C2
Machine instructions count in which the program is translated	5×10^9	1×10^9
Clock frequency	4 GHz	3 GHz
CPI	0,9	0,75

   Which computer is faster C1 or C2? **(16 points)**

2. We want to improve the execution time of programs by replacing single core processor with multicore processor with eight (8) cores. By how much is the execution time of programs improved, if we know that 40% of programs can't be processed in parallel? **(18 points)**

3. Consider a computer with 3-level memory hierarchy including cache, main memory and virtual memory:
    - Cache memory has access time 2 clock cycles and hit rate 97%;
    - Time to transfer block from main memory ta cache is 60 clock cycles (miss penalty), miss rate in main memory is $0,2*10^{-5}$ (0,2 * ten to power minus five);
    - Time to transfer block from virtual memory to main memory is $2*10^6$ (two million) clock cycles.
    a) Calculate the average access time (in clock cycles) of memory hierarchy. **(14 points)**
    b) Calculate the average access time in seconds if the clock frequency is 4,2 GHz. **(6 points)**

4. Computer with virtual memory realized with paging has 64GB of virtual memory and 4GB of physical memory. Page size is 8KB, memory word is 1B (8 bits) long.
    a) Calculate the minimum length of virtual and physical memory address in bits. **(8 points)**
    b) Calculate the size of the page table in bytes, if each descriptor in page table is 24 bits long. **(10 points)**

5. Briefly explain (and/or sketch) the difference between Princeton and Harvard memory architecture, and explain which one is faster and why. Which architecture is usually used for the main memory? **(12 points)**

6. You have given the following program in a high-level language (Phyton):

```
tabela1 = [10,9,8,7,6]
tabela2 = [ 1,2,3,4,5]
tabela3 = [ 0,0,0,0,0]
tabela4 = [ 0,0,0,0,0]
len     = 5

for i in range(0,5):
    tabela3[i] = tabela1[i] + tabela2[i]
    tabela4[i] = tabela1[i] - tabela2[i]
```

   Write the same program in assembly language for processor ARM9. Use indirect addressing mode without offset. Here you have prepared part of a program in assembly language: **(16 points)**

```
                    .text
TABELA1:            .byte   0x0A, 0x09, 0x08, 0x07, 0x06
TABELA2:            .byte   0x01, 0x02, 0x03, 0x04, 0x05
TABELA3:            .space  5
TABELA4:            .space  5
LEN:                .byte   5

                    .align
                    .global __start
__start:

__end:              b    __end
```

Results will be available on Thursday 26. 1., oral exam will be held from Monday 30.1.
Please log on your chosen time and date for oral exam on Učilnica.