NWEN242 homework assignment 1

Due date: Thursday **6 August 2015** at **23:59**

Total marks: **32 Marks**

Question 1: Suppose you have a machine which executes a program consisting of **50%** (in terms of execution time) floating point multiply, **20%** floating point divide, and the remaining **30%** are from other instructions.

(a) Management wants the machine to run **1.4 times** faster. You can make the divide run at most **3 times** faster and the multiply run at most **8 times** faster. Can you meet management's goal by making only one improvement, and which one? **[2 marks**]

(b) A new general manager has now taken over the company removing all the previous managers. If you make both the multiply and divide improvements, what is the speed of the improved machine relative to the original machine? [**2 marks**]

Question 2: Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3 GHz clock rate and a CPI of 1.5. P2 has a 2.5 GHz clock rate and a CPI of 1.0. P3 has a 4.0 GHz clock rate and has a CPI of 2.2.

(a) Which processor has the highest performance expressed in instructions per second? [**3 Marks**]

(b) If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions for each processor. [**3 Marks**]

(c) We are trying to reduce the execution time by 30% (i.e. execution time is reduced from 10 seconds to 7 seconds) but this leads to an increase of 20% in the CPI. For each processor, what clock rate should we have to get this time reduction? [**3 Marks**]

Question 3: Identify and briefly explain five main functional components in a computer system. [**5 Marks**]

Question 4: For the MIPS assembly instructions below, what is the corresponding C statement? Assume that the variables f and g are assigned to registers $s0 and $s1, respectively. Assume that the base address of the arrays A and B are in registers $s6 and $s7, respectively. [**2 Marks**]

```
sll  $t0, $s0, 2     # $t0 = f * 4
add  $t0, $s6, $t0   # $t0 = &A[f]
sll  $t1, $s1, 2     # $t1 = g * 4
add  $t1, $s7, $t1   # $t1 = &B[g]
lw   $s0, 0($t0)     # f = A[f]
addi $t2, $t0, 4
lw   $t0, 0($t2)
add  $t0, $t0, $s0
sw   $t0, 0($t1)
```

Question 5: Translate the following C code to MIPS. Assume that the variables i and j are assigned to registers $s3 and $s4, respectively. Assume that the base address of the arrays A and B are in registers $s6 and $s7, respectively. Assume that the elements of the arrays A and B are 4-byte words: [**8 Marks**]

B[8] = A[i] + A[j];

Question 6: The following instruction is not included in the MIPS instruction set:

rpt $t2, loop # $at=$t2; $t2=$t2-1; if ($at == 1) PC=PC+4+BranchAddr

(a) If this instruction were to be implemented in the MIPS instruction set, what is the most appropriate instruction format? [**2 Marks**]

(b) What is the shortest sequence of MIPS instructions that performs the same operation? [**2 Marks**]