Computer Organization & Assembly Language

Midterm Exam – 2017/11/23

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1. Answer "True" or "False" to the following statements. (30%)
   (A) The interface between application software and system software is called instruction set architecture.
   (B) The yield decreases as there are more and more defects on the wafer.
   (C) The compiler always maps a C language statement to several MIPS instructions.
   (D) The "shamt" field is not used by the add instruction but is used by the `sw` instruction.
   (E) The `lw` instruction assembles into two machine code instructions.
   (F) Memory is a hierarchy of devices with faster and more expensive ones closer to CPU.
   (G) A left shift instruction can replace an integer multiply by a power of 2 if no overflow occurs.
   (H) Either overflow or underflow may occur for integer operations.
   (I) When performing the binary multiplication operation for computers, it may not be necessary to add the Multiplicand to the Product in all iterations.
   (J) Since computer arithmetic is with limited precision, computation results obtained from computers are usually erroneous and suspicious.

2. Answer the following questions briefly. (10%)
   (A) How many bits are used to represent an "unsigned int" in C?
   (B) What is the total number of MIPS registers?
   (C) What is the size of a MIPS register?

3. Assume that a company exclusively uses three application programs, A, B, and C for 60%, 10%, and 30% of the time, respectively. Based on the execution-time benchmarks in the table below, Dilbert, a chief executive of this company, must choose a computer system based on performance and cost. (For example, if Dilbert, spends 10% more on a computer system, he expects a 10% increase in performance.)

System	Execution Time (sec.)			Cost
	Application A	Application B	Application C	
X	90	10	15	$1,400
Y	80	25	20	$1,200
Z	75	35	30	$1,800

What would you recommend to Dilbert? (6%)

4. For the following set of variables, identify all of the subsets that can be used to calculate execution time. Each subset should be minimal; that is, it should not contain any variable that is not needed. Note that MIPS stands for "*million instructions per second*".
{CPI, clock rate, cycle time, MIPS, number of instructions in program, number of cycles in program} (8%)

5. Translate the following C code to MIPS. Assume that the variables f, g, h, i, and j are assigned to registers `$s0`, `$s1`, `$s2`, `$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%)

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

6. Assume the following register contents:

`$t0 = 0xAAAAAAAA, $t1 = 0x12345678`

For the register values shown above, what is the value of `$t2` for the following sequence of instructions, respectively? (8%)

(A)
```
sll   $t2, $t0, 4
andi  $t2, $t2, -1
```

(B)
```
srl   $t2, $t0, 3
andi  $t2, $t2, 0Xffef
```

7. Given your understanding of PC-relative addressing, explain why an assembler might have problems directly implementing the branch instruction in the following code sequence: (6%)
```
here:   beq $t1, $t2, there
...
there:  add $t1, $t1, $t1
```

8. What are the two most important parts in an object file for further linking process? (6%)

9. Show the IEEE 754 binary representation for the floating-point number $1/3_{ten}$ and $2/3_{ten}$ in single precision, respectively. In addition, use your results to perform the binary addition: $1/3_{ten} + 2/3_{ten}$. What is the sum in decimal? (14%)

10. When using the IEEE 754 format, what is the meaning of *overflow* and *underflow*, respectively? (4%)