Comp 411 Computer Organization Spring 2009
Midterm #2 – 9 April 2009

Don't Panic! Make assumptions if necessary, write them down, and proceed. Write your answers on this sheet or on the back if you need more room. Open books and notes. You may use your computer but only for access to the class web site. If I can't decode your writing then your answer is wrong.

1. Circle the values that can**NOT** be EXACTLY represented by an IEEE single-precision floating-point number: (A) 0 (B) 4.4 (C) 44 (D) 11.5 (E) 3.125

2. Circle the formulas for execution time that are valid. (CPI is cycles per instruction, I is number of instructions, T is cycle time, R is clock rate, C is number of cycles in the program)
(A) CPI × I × T (B) CPI × I / R (C) C / T (D) C × R (E) T × R

3. In a certain state automotive tags are assigned a unique ID composed of eight characters as follows: the first three characters are letters (A-Z), followed by a dash (-), and 4 decimal digits (0-9). How many bits are required to encode these tag numbers?

4. All of the following equations are true for the idealized numbers you studied in algebra. Circle the ones that are true for IEEE floating point numbers. Assume that all of the numbers are well within the range of largest and smallest possible numbers (that is, underflow and overflow are not a problem)
(A) X+Y=X if and only if Y=0
(B) (X+Y)+Z = X+(Y+Z)
(C) X+Y = Y+X
(D) X+1 != X

5. Soon we will all have computers with multiple processors. This will allow us to run some kinds of programs faster. Suppose your computer has N processors and that a program you want to make faster has some fraction F of its computation that is inherently sequential (either all the processors have to do the same work thus duplicating effort, or the work has to be done by a single processor while the other processors are idle). What speedup can you expect to achieve on your new computer?

6. In a certain set of benchmark programs about every 4^{th} instruction is a load instruction that fetches data from main memory. The time required for a load is 50ns. The CPI for all other instructions is 4. Assuming the ISA's are the same, how much faster will the benchmarks run with a 2GHz clock than with a 1GHz clock?

7. Consider the characteristics of two machines M1 and M2. M1 has a clock rate of 2GHz. M2 has a clock rate of 4GHz. There are 4 classes of instructions (A-D) in the instruction set. In a set of benchmark programs, the frequency of each class of instructions is shown in the table.

Instruction Class	Frequency	M1 CPI	M2 CPI
A	40%	2	6
B	25%	3	6
C	20%	3	6
D	15%	5	8

What is the average CPI for each machine? CPI1 = 2*.4+3*.25+3*.2+5*.15 = 2.9; CPI2 = 6*.4+6*.25+6*.2+8*.15 = 6.3. Which machine is faster? By what factor faster is it? What is the cycle time of each machine?

8. Suppose two positive single-precision floating point numbers to be added have their E field (exponent + bias) values of 200 and 150 respectively. What will be the value of the E field of the result?

9. When multiplying unsigned integers that are N bits long using the shift and add algorithm, how many additions are required on average if all multipliers are equally likely?
(A) N (B) $\log_2(N)$ (C) N/2 (D) N^2 (E) 2N

10. How many carries occur in a twos-complement adder when adding 203 to 213?
(A) 0 (B) 8 (C) 7 (D) 1 (E) 416

11. How many bits of ROM are required to store an arbitrary binary function with 4 inputs and 3 outputs?

12. How many bits of the encoding for R-type instruction are devoted to specifying the registers?

13. What is the function of the RA register in the MIPS ISA?