Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Computer Organization (CS 345)**

**Exam 1**

Part 1: Short Answer (30 points)

a) History (2 points each)

1. Who was Grace Hopper? What is she famous for?
2. What did Charles Babbage invent? What is he famous for?

b) Performance (2 points each)

1. Given a program that runs in 350s on a single processor, what is the theoretical best runtime of the program if 250s of the program may be parallelized?
2. What is the maximum speed up for that program?
3. What is the performance of the program if it runs on one processor? What is the performance using an infinite number of processors?
4. What is the cycle time (also called the period) of a 2 GHz processor?
5. How many cycles per second may be executed on a 2 GHz processor?
6. If you are given an add instruction that takes 4 cycles to complete on a 2 GHz processor, how long (in nanoseconds) will it take to run 10 add instructions?

c) Assembly: Assume the integers x, y, and z are in registers $t1, $t2, and $t3, respectively. Assume the address of an integer array “arr” is stored in $s1. Convert the following Java statements to MIPS assembly (2 points each)

1. x + y >= z
2. x && y && z
3. z = (x + y) \* z – x
4. arr[0] = arr[4] \* arr[8]

d) Conversions (2 points each)

1. Convert 1001 1110 1010 0010 binary to hexadecimal.
2. Convert 123 decimal to binary
3. Convert 111001 binary to decimal

Part 2: Long Answer (70 points, 10 points each)

1. What are the five basic parts of a computer? Briefly explain each.
2. Write an assembly program to compute the area of a rectangle.
3. Assume that for the previous problem, you need to compute areas of two shapes: a circle and a rectangle. Write an if-elseif-else statement in assembly to select the appropriate mathematical operation using 1 to represent a circle and 2 to represent a rectangle. Provide an error message if invalid input is provided. Do NOT write the code to compute the areas in your solution.
4. If you are given a program that runs in 10s on a 3 GHz processor that consists of 50% adds, 25% multiplies, and 25% moves, how many instructions are executed in one run of the program? Assume adds cost 3 cycles, multiplies cost 4 cycles, and moves cost 2 cycles. Hint: use the average cycles per instruction.
5. There are five errors in the following assembly code. There are no errors in the commented Java code. What are the errors? Explain.

#DoWhileExample.asm

#An example of a do-while loop using slt and bne

#

# This example represents the following Java code:

# int i = 0, n = 10;

# do

# {

# i++;

# System.out.println(i);

# } while (i < n);

#

# where i is $t1 and n is $t2

.data

 newLine: .double "\n"

.text

 main:

 li t1, 0 #initialize i to zero

 li $t2, 10 #initialize n to ten

 do: #do loop operations

 subi $t1, $t1, 1 #increment i

 li $v0, 1 #print i or $t1

 move $a0, $t1 #copy contents of $t1 into $a0

 syscall

 li $v0, 4 #print a newline character

 la $a0, newline

 syscall

 slt $t3, $t1, $t2 #compare i to n

 beq $t3, $zero, do #keep going if i < n

 li $v0, 10 #end the program

 sys

1. Determine the binary and hex representations for the following MIPS instructions:

addi $s3, $t5, 73

 div $s7, $t0, $t3

1. Compare and contrast analytical and empirical benchmarking. Be sure to explain FLOPS, MIPS (the instruction rating not the processor), and experimental benchmarks in your comparison.