CS Sample MidTerm Examination

Student Name:_____**Signature:** _____

Question 1 (Digital Circuits). [30%]

Your task is to design a digital circuit which implements a version of a shift **logical** left or a shift **logical** right. Let A_2, A_1, A_0 represent the 3 bits of a 3-bit register, where A_2 is the most significant bit. Let S_1, S_0 represent the higher and lower bits, respectively, of a 2-bit **signed** binary number, which will be interpreted as a shift amount. Positive values will denote logical shifts to the left and negative values logical shifts to the right. This circuit should generate three outputs F_2, F_1, F_0 which are the three bits left in the 3-bit register after its contents are shifted by the shift amount.

a) Generate the truth table for the outputs F_2, F_1, F_0 as functions of the inputs.[10 marks]

b) Derive a minimized sum-of-products expression for each of the three outputs F_2, F_1, F_0, as functions of the inputs, using K-maps, **but do not worry about the case of logical shifts to the right**.[20 marks]

Hint: Use the sign of the shift amount to identify the cases you need to represent.

(In part b, don't use K-maps since we didn't cover them this year, but try to simplify the expressions using the laws of Boolean algebra.)

Question 2 (Number Representation). [20%]

a) Suppose you have a m-digit unsigned number in base 8. What is the largest value that such a number can take on? If such a number is to be represented in base 2 using n digits, what is the precise relationship between n and m? [10 marks]

b) Represent -102.25 as an IEEE single precision floating point number. [10 marks]

Question 3 (MIPS). [50%]

In this question you are asked to complete the MIPS code below to implement a subroutine which tests whether or not an input string is a palindrome. A palindrome is a string which reads the same way when read backwards and forwards. For example, the string "12fo-rof21" is a palindrome. The string you are asked to test has an associated label "string". The NULL termination character should not be considered for the palindrome test, but your code should work for any such test string. For all your working your use of registers should conform to the conventions introduced in class. Be sure to comment your code carefully. Note that the "main" routine is already written. Proceed as follows:

a) Assume a subroutine called "length" has already been written for you.

b) Complete the subroutine "palind" which takes as input two arguments, the first being a pointer to the first element in a string and the second being the length of the string. This routine should return a value of 1 if the test string is a palindrome and 0 otherwise. Do not use recursion for this part.[20 marks]

c) Come up with an entirely new version of the subroutine "palind" which is recursive. To do so you need to first come up with the proper recursive step. *Hint: A string having one element is a palindrome. A string having two elements is a palindrome if ... A string having 3 elements is a palindrome if ...* [20 marks]


```
#         Your program begins here.
          .data
string:   .asciiz ''CabBiafadodafaiBbaC'' # this is the test string

          .text
          .align 2
          .globl main

length:                                   # first line of ''length'' subroutine

          jr $ra                          # last line of ''length''

palind:                                   # first line of ''palind'' subroutine

          jr $ra                          # last line of ''length''

main:     la $a0,string                   # ''main'' program begins by getting pointer
          jal length                      # to the string and calling ''length''
          add $a1,$v0,$zero               # now set up the arguments for ''palind'' and
          la $a0,string                   # call it
          jal palind
          nop                             # last line of ''main''
```