

Practice Exam 1**Name:** _____

You will have 60 minutes for this exam. This exam is open book and note. Please allow some time to check your work. If you need extra space, write on the back. There are a total of 30 points on this exam.

1. (4 points) What is the output of the following C++ program, assuming that characters are encoded in ASCII as usual? Recall that $\&$ is the bitwise-AND operator and $|$ is bitwise-OR.

```
#include <iostream>
using namespace std;

int main()
{
    char msgA[13] = "Hello World!"; // 13 characters, including terminating NUL
    char msgB[13];

    for (int i = 0; i < 13; i++) {
        char ch = msgA[i];

        if ((ch & 96) == 64) {
            msgB[i] = ch | 32;
        } else {
            msgB[i] = ch;
        }
    }

    cout << msgA << endl;
    cout << msgB << endl;
}
```

2. (6 points) Give the result of evaluating each of the following expressions, and tell which of the Pep/8 status flags (NZVC) would be set afterward. All numbers are in hexadecimal, as should be your results.

(a) $7531 + 3FFF$

(b) $FFFE + 8001$

4. (6 points) Convert the following C++ program to Pep/8 Machine Language (you may assume that the result of $1 + 1$ is a single digit, but you should not simply hard-code the character '2'...):

```
#include <iostream>
using namespace std;

int main() {
    cout << '4';
    cout << 1 + 1;
    cout << endl;
}
```

5. (6 points) Consider the following recursive function in C++ (it computes entries in a table known as the Bell Triangle, which can be used to count the number of ways to partition n distinct objects into nonempty sets):

```
int B(int n, int k)
{
    int temp;

    if (k == 0 && n == 0) return 1;
    if (k == 0) return B(n-1, n-1);

    temp = B(n, k-1);
    return temp + B(n-1, k-1);
}
```

- (a) Sketch the layout of items in a stack frame for this function:

- (b) Show the call tree for the function call $B(2, 1)$:

- (c) If each `int` occupies 2 bytes, and memory addresses also take 2 bytes, then what is the minimum number of bytes needed on the runtime stack to process the function call $B(2, 1)$?