						Total	
1	2	3	4	5	6		

Name:_____

CS 320
Introduction to Parallel Programming
Midterm Exam
March 3, 2004

1. **Data and functional parallelism** [5 pts.]

Identify *all* sources of data and functional parallelism in the following program segment:

```
f1:  for i←0 to 99 do
s1:        a[i]←b[i]+c[i]
s2:        d[i]←e[i]+f[i]
s3:        g[i]←a[i]+d[i]
     end for

s4:  h[0] = 10^10;

f2:  for i←1 to 99 do
s5:        h[i]←sqrt(h[i-1])
     end for

f3:  for i=0 to 99 do
s6:        m[i]←h[i]+a[30]
     end for
```

2. **Static versus self-scheduling** [5 pts.]

Suppose we are going to speed up the execution of the data clustering algorithm presented in Chapter 1 of the textbook by using p processors to generate the D-dimensional vectors for each of the N documents. one approach would be to preallocate about N/p documents to each processor. Another approach would be to put the documents on a list and let processors remove documents as fast as they could process them. Discuss one advantage of each approach.

3. **MPI reductions** [5 pts.]

Write a parallel program that computes the sum $1+2+...+p$ in the following manner: Each process i assigned the value i+1 to an integer variable, and then the processes perform a sum reduction of these values. Process *0* should print the result of the reduction. Assume a total of p processes.

4. Point-to-point communication [5 pts.]

Consider the following code segment:

```
int x,y,z, i, j ,k ;
int id, p;
MPI_Status status;
MPI_Comm_rank(MPI_COMM_WORLD, &id);
MPI_Comm_size(MPI_COMM_WORLD, &p);
...
y=id;

j = id-1;
if (j < 0) j=p-1;
k=id+1;
if (k>p-1) k=0;
MPI_Recv(&x, 1, MPI_FLOAT, k, 0, MPI_COMM_WORLD, &status);
MPI_Send(&y, 1, MPI_FLOAT, j, 0, MPI_COMM_WORLD);
z = x + y;
```

Fix the MPI-related bug in this program and state what is the value of **`z`** at the end of the program.

5. Performance analysis [5 pts.]

The execution time of Floyd's algorithm is computed in the textbook as:

$$n^2\left\lceil \frac{n}{p} \right\rceil \chi + n(\log p)\lambda + \lceil \log p \rceil 4\frac{n}{\beta}$$

Here, we assume that n=1000, χ = 25.5 nsec, λ= 250 μsec, and $\beta = 10^{7}$.

The value of this formula for p=1, 2, 3, 4, 5, 6, 7, and 8 is respectively:

25.5000, 13.0000, 9.0170, 6.8750, 5.8500, 5.0085, 4.3965, and 3.9375

Compute the Karp-Flatt serial fraction for p=2, 4, and 8. Explain the meaning of the values obtained for the serial fraction. Hint: Watch the units!

<Extra credit>.**Ceilings and floors** [2 pts.]

Prove the following formula:

$$\left\lfloor \frac{m+n-1}{n} \right\rfloor = \left\lceil \frac{m}{n} \right\rceil$$