Practice Problems for Quiz 1

1. A parallel program should produce the same result as that of the corresponding serial program. Consider the following code fragment:

```
int a[100], b[100];
int i;


for (i = 0; i < 100; i++)
  {
    a[i] = 0;
    b[i] = 2* (i + 5) + 3;
  }

a[0] = a[1] = 1;

#pragma omp parallel private(i)
{
 #pragma omp for
  for(i = 2; i < 100; i++)
  {
    a[i] = 2*a[i-1] + 5*a[i-2] + 10;
  }

  for(i = 2; i < 100; i++)
  {
    a[i] = 5*a[i-1] + a[i-2]*a[i-1] + 2;
  }

  # pragma omp for
  for(i = 2; i < 100; i++)
  {
    a[i] = b[i-1] + 3*b[i-2]  + a[i];
  }

}
```

   (a) Would the above program produce correct result (the same as produced by a serial program) when run using multiple threads?

   (b) Which of the **for** loops produce correct and which ones produce incorrect result?. Explain your answer.

   (c) Do you notice any race conditions? Would the race conditions affect the output?

2. Consider the following nested loop:

```
int m, n;
........
float a[m][n];
........
........

for(i = 0; i < m; i++)
   {
    for(j = 0; j < n; j++)
       {
         a[i][j] = (a[i-1][j] + a[i][j] + a[i+1][j])/4;
       }
   }
```

   Parallelize the above nested loop using OpenMP. Explain the reason for your choice of parallelization.

3. Consider the following system of linear equations,

$$x_1 + 2x_2 + x_3 = 0 \quad (1)$$
$$2x_1 + 2x_2 + 3x_3 = 3 \quad (2)$$
$$-x_1 - 3x_2 = 2 \quad (3)$$

   (a) Solve the above system of equations using LU decomposition and obtain the solution vector (x_1, x_2, x_3).

   (b) Perform one iteration of the Jacobi method and report the values of the solution vector. Use an initial guess of $(0, 0, 0)$.

   (c) Perform one iteration of the Guass-Seidel method and report the values of the solution vector. Use an initial guess of $(0, 0, 0)$.

   (d) Which one of the two iterative methods produces an answer closer to the exact solution and why?

4. Explain in your own words using a small code fragment (if required) about what does the following OpenMP directives and clauses mean and their use:

   (a) parallel

   (b) threadprivate

   (c) firstprivate

   (d) lastprivate

5. Extend the red-black Guass-Seidel iteration solver to the solution of a three-dimensional Poisson equation on a uniform Cartesian grid. Write a small code fragment to accomplish the same by appropriately using relevant OpenMP directives.