CSC 478 Winter 2010 exam 2. Due date: Thursday March 25, before class.

This exam is worth 10% of your course grade, graded on a 100-point scale (all questions are weighted equally). The exam should be submitted in a document through the file upload, emailed, or handed-in in person on the due date. Although a typed is preferred, (scanned) hand-written is also acceptable as long as it is legible.

1. Transactional memory is an alternative form of a process/thread synchronization mechanism. Explain how it works, relating its relative advantages and disadvantages as compared to locks.

2. Consider a sequential pseudocode as follows:

```
for i = k to n {
  if (a[i] != b[i])
    a[i] = a[i] * b[i] / (a[i] - b[i]);
}
```

   This is to be parallelized for execution on a SIMD machine. If you do not consider data layout, then strip mine the above loop for execution on 8 PEs.

3. Consider the following pseudocode parallel program, which computes the histogram of a data array. x0 and x1 are minimum and maximum values, respectively, in the array x[1:N]. The histogram vector is h[0:M-1]

```
shared scale, M, x0, x1, x[N], h[M];
private i, j;
scale = M/(x1 - x0);
for i = 1 to N-1 fork DOELEMENT;
i = N;
DOELEMENT:
  j = leastint(scale*(x[i] - x0) );
  h[j] = h[j] + 1;
  join(N);
```

   identify the operations that require a critical section and show how the code should be modified using the “critical/end critical” construct.

4. Parallel algorithm models. The following are parallel algorithm models suitable for either SIMD or MIMD machines. Research what these are and describe each of them.

   (a) data parallel model

   (b) work pool model

   (c) master-slave model

   (d) task graph model

   (e) pipeline or producer/consumer model

5. Ignoring process start-up in the main program and considering only floating point operations on a and x, calculate the efficiency of Program 4-4 as a function of n, assuming one processor per process.

6. A SIMD computer's pipelined vector unit has 10 stages and a stage cycle time that is 20 picoseconds. Ignoring instruction issue time,

   (a) Characterize it in terms of its asymptotic rate r_∞

   (b) Determine the vector length $n_{\frac{1}{2}}$ required for 50% efficiency.

7. Consider a parallel program in which a create is used to execute a function in parallel (e.g. something similar to pthread_create). If a variable is read-only in the (parallel) function, then why should it be pass-by-value and not pass-by-reference?

8. Write a version of program 4-6 that uses block prescheduling, in which you assume that the number of processes, P, divides n evenly such that the block size $m = n/P$. Count the number of multiply-adds done by process k, where $0 \leq k \leq P - 1$.