National University of Computer and Emerging Sciences

Parallel and Distributed Computing (CS3006)

Date: Nov 5th 2024

Sessional-II Exam

Total Time: 1 Hour
Total Marks: 30
Total Questions: 5

Course Instructors:
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Semester: Fall-2024
Campus: Lahore
Dept: CS

Vetted by _____ Vetter Signature _____

CLO # 3: Perform analytical modelling, dependence, and performance analysis of parallel algorithms and programs.

Q1: Draw a 16 nodes ring structure. Considering message on all nodes, perform all-to-one reduction on this structure. Node 0 is the destination node of all-to-one reduction operation. Show all the steps involved in the all-to-one reduction operation. **[6 marks]**

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Q2: In a mesh architecture consisting of two rows and four columns, perform scatter operation. Assume that Node 0 serves as the source for all messages. Outline all the steps in this process with several figures and compute the communication cost of the operation. **[4 + 2 marks]**

CLO # 2: Implement different parallel and distributed programming paradigms and algorithms using Message-Passing Interface (MPI) and OpenMP.

Q3: Show the output of the following program, assuming no error in the code. **[6 marks]**

```
#include <iostream>
#include <omp.h>
using namespace std;

int main() {
   int nums[12] = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 };
   omp_set_num_threads(3);

   #pragma omp parallel for schedule(static, 4)
    for (int j = 0; j < 12; j++) {
       nums[j] *= (j+4);
       int x = omp_get_thread_num();
       cout << "At thread: " << x << " iteration: ";
       cout << j << endl;
    }

    for (int i = 0; i < 12; i++) {
       cout << nums[i] << " ";
    }

    cout << endl;
    return 0;
}
```

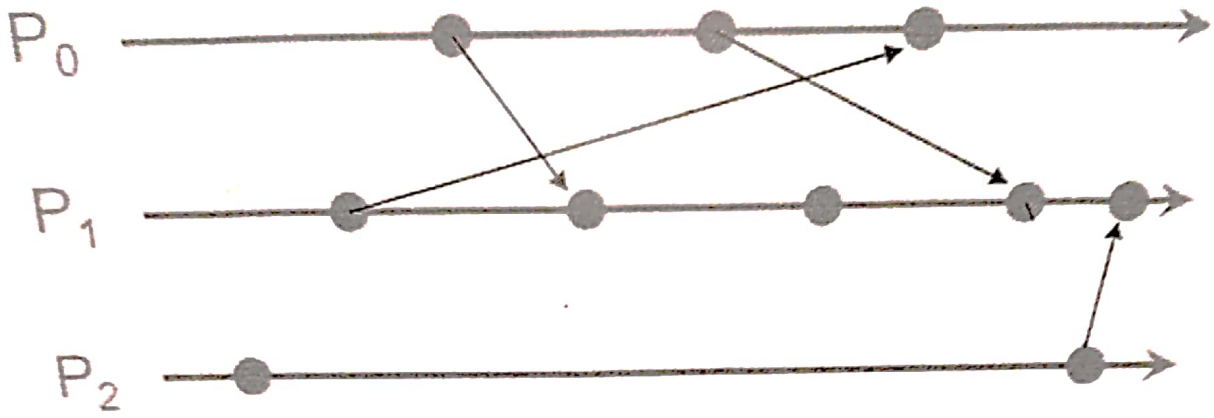
CLO # 2 Implement different parallel and distributed programming paradigms and algorithms using Message-Passing Interface (MPI) and OpenMP.

Q4: Consider the following OpenMP code snippet. What will be the output of the program? Explain how the variable sum is updated across multiple threads. **[2 + 4 marks]**

```
#include <stdio.h>
#include <omp.h>

int main() {
  int sum = 0;
  int n = 10;
  #pragma omp parallel num_threads(2)
  {
    int thread_sum = 0;

    #pragma omp for
    for (int i = 0; i < n; i++) {
      thread_sum += i;
    } //code continued in next column

    #pragma omp critical
    {
      sum += thread_sum;
    }
  }

  printf("Total Sum: %d\n", sum);
  return 0;
}
```

CLO # 3: Perform analytical modelling, dependence, and performance analysis of parallel algorithms and programs.

Q5 [For sections BCS-7A and BCS-7B ONLY]: Assign Vector-clock timestamps to the following events as per the definition of vector clocks: **[6 marks]**



CLO # 3: Perform analytical modelling, dependence, and performance analysis of parallel algorithms and programs.

Q5 [For section BCS-7C ONLY]: Calculate the time required to transfer 500 mbits of data from Sender to Receiver3. Bandwidth of the links is 5 mbits/s. **[6 marks]**