BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI (RAJ.)
II SEMESTER 2019-2020
Comprehensive Examination

Course No.: CS F422   **Course Title:** **Parallel Computing**
Date: **12th May 2022 (8-11)**   **Maximum Marks:** **35**
Exam Type: Part B (Open Book)   **Part B Marks:** 20

Note:
- Write all parts of a question together.

Q1) Consider a pattern matching algorithm given below.

```
Void search(char* pat, char* txt)
{
    int M = strlen(pat);
    int N = strlen(txt);

    /* A loop to slide pat[] one by one */
    for (inti  = 0; i <= N - M; i++) {
        int j;

        /* For current index i, check for pattern match */
        for (j = 0; j < M; j++)
            if (txt[i + j] != pat[j])
                break;

        if (j == M) // if pat[0...M-1] = txt[i, i+1, ...i+M-1]
            printf("Pattern found at index %d \n", i);
    }
}
```

(a) Using Foster's design methodology, explain how would you parallelize this algorithm.
(b) Considering a message passing parallel computer with p processors, implement your parallel algorithm in MPI.
(c) Comment on the cost-optimality of the parallel algorithm.
(d) Analyze the parallel time complexity and scalability.

[2+4+1+1=8M]

Q2) An array of type float elements is to be processed in a one-element-per-thread fashion by a GPU. Suggest an execution configuration for the following scenarios:
(a) The array is 1D and of size N. The target GPU has 8 SMs, each with 16 SPs.
(b) The array is 2D and of size NxN. The target GPU has 5 SMs, each with 48 SPs.
For each of these scenarios calculate the minimum size that N should satisfy to make the GPU computation a desirable alternative to CPU computation.

[2+2=4M]

Q3) Consider the format of data with sample data given in the following table. This is the data of registered courses.

Year	Semester	StudentId	CourseId
2019	1	Id1	cid1
2019	2	Id2	cid2
2020	1	Id3	cid1
2020	1	Id4	cid1
2019	2	Id5	cid2
2019	2	Id2	cid2

For each semester in a year, we need to find out the list of students who have taken the maximum number of courses in a semester. Design map-reduce application with pseudo code for map() and reduce() tasks.

[4M]

Q4) In shared memory programming, locks are used to serialize the access to critical sections. Consider that there is a procedure named Element dequeuer(Queue q) which removes and returns the last element in a given queue.

```
Element dequeuer(Queue q){
        Element e;
        pthread_mutex_lock(&mutex);
        //code
        pthread_mutex_unlock(&mutex);
        return e;
}
```

Considering that the application uses several queue data structures, suggest a locking scheme with better performance.

[2M]

Q5) For the following, justify whether they are true or false.
   (a) Using E-cube routing on hypercube of d dimensions, communication between any two nodes can be utmost d hops.
   (b) Number of registers in a SM determine the block and grid sizes in GPU programming.

[2M]

--&--

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI (RAJ.)
II SEMESTER 2021-2022
Comprehensive Examination

Course No.:	CS F422	**Course Title:**	**Parallel Computing**
Date:	**12th May 2022 (8-11)**	**Maximum Marks:**	**35**
Exam Type:	Part A (Closed Book)	Part A Marks:	15

Note:
- Write answers in this sheet itself.
- Overwritten answers will not be accepted for rechecks.
- After submitting part A, collect part B.

IDNO:_____   **NAME:**_____

Q1) **There can be more than one choice correct.** *Only if all correct options and only correct options are chosen, marks will be awarded.* **Write answers in the grid. Each carries 0.5 mark.**

1	2	3	4	5	6	7	8	9	10

Recheck:								Q1	Q2	Q3	Total

1. MPI program is compiled using
   - (a) mpigcc
   - (b) gcc
   - (c) gcc –mpi
   - (d) mpicc
2. MPI_Reduce function
   - (a) requires point to point communication
   - (b) requires collective communication
   - (c) applies given operator associatively on the data held by each process
   - (d) reduces number of dimensions in input data
3. Cost of one-to-all broadcast operation on a hypercube of p nodes is _ _ _.
4. With respect to map reduce framework,
   - (a) reduce task can't have several keys in its input
   - (b) a key can be with utmost one reduce task only
   - (c) there can be only one reduce job
   - (d) there can be only one map job
5. MPI follows _ _ _ style of programming
   - (a) SIMD
   - (b) SPMD
   - (c) MPMD
   - (d) SISD
6. In Foster's design methodology, the process of grouping tasks into larger tasks in order to improve performance or simplify programming is called
   - (a) Partitioning
   - (b) Communication
   - (c) Agglomeration
   - (d) Mapping
7. Mapping strategy used when number of tasks is static, communication is structured and roughly constant time per task is
   - (a) Use static load balancing algorithm
   - (b) Use dynamic load balancing algorithm
   - (c) Cyclically map tasks to processors
   - (d) Create one task per processor
8. A collective communication method in MPI
   - (a) is called by all processes in the communicator
   - (b) is called only by a few in the communicator
   - (c) uses tags to match messages
   - (d) do not use tags to match messages
9. W.r.t CUDA, choose the correct options
   - (e) Host and GPU memories are disjoint
   - (f) Host can access shared memory of GPU
   - (g) Thread index is unique globally
   - (h) Thread index is unique within the block
10. Cost of scatter operation on a linear array of p nodes is _ _ _ _.

Q2) Briefly answer the following questions. 6M

1. Using Gray codes, suggest a mapping of nodes from 8-node linear array to 8-node hypercube so that there is dilation of one and congestion of one. 2M

2. Using 1D row-wise partitioning of a matrix, compute parallel runtime and iso-efficiency function for matrix-vector multiplication problem. Matrix of size nxn and vector nx1. There are p processes where p<n. 2M

3. Explain the steps involved in all-to-all broadcast communication on a 2D mesh of $\sqrt{p}$ rows and $\sqrt{p}$ columns. Derive the cost of communication. 2M

Q3) Write a CUDA program for adding two vectors and storing result in a third a vector. Syntax errors are not penalized. 2M

Q4) Write an MPI program for adding two vectors and storing result in a third a vector. Syntax errors are not penalized. 2M

--**&**--