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Printed Page:-4 **Subject Code:- BCSAI0304**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)
B.Tech
SEM: III - THEORY EXAMINATION (2025 - 2026)
Subject: High Performance Computing

Time: 3 Hours **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*
1. *This Question paper comprises of* ***three Sections -A, B, & C.*** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*
2. *Maximum marks for each question are indicated on right -hand side of each question.*
3. *Illustrate your answers with neat sketches wherever necessary.*
4. *Assume suitable data if necessary.*
5. *Preferably, write the answers in sequential order.*
6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION-A 20

1. Attempt all parts:-

1-a. A key driver for HPC adoption in industries is:(CO1,K1) 1

(a) Speed of email delivery
(b) Limiting network bandwidth
(c) Ability to process massive datasets
(d) Reducing processor cores

1-b. MPI is commonly used for:(CO1,K2) 1

(a) Shared memory communication
(b) Message passing in distributed systems
(c) Increasing disk space
(d) GPU rendering

1-c. Flynn's taxonomy category that executes the same instruction on different data is called _____.(CO2,K2) 1

(a) SISD
(b) SIMD
(c) MISD
(d) MIMD

1-d. Image filtering is a real-world application of _____ parallelism.(CO2,K2) 1

(a) Data
(b) Compiler optimization
(c) Pipeline
(d) File handling

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1-e. Apply the MPI routine to gather results from all processes to rank 0.(CO3,K2) 1

(a) MPI_Scatter
(b) MPI_Gather
(c) MPI_Reduce
(d) MPI_Bcast

1-f. Identify the number of neighbors per node in a 3D torus network with 27 nodes.(CO3,K3) 1

(a) 3
(b) 4
(c) 6
(d) 8

1-g. Recall the function of LAPACK in numerical computation.(CO4,K2) 1

(a) Linear algebra solvers
(b) Compiler optimization
(c) Memory management
(d) Cloud orchestration

1-h. Use knowledge of mission-critical systems to identify the essential requirement for maintaining continuous operation.(CO4,K3) 1

(a) Minimal downtime and high reliability
(b) Low-cost hardware
(c) Casual monitoring
(d) Only single-node processing

1-i. Genomic sequencing requires HPC because of:(CO5,K2) 1

(a) Small data sizes
(b) Cloud unavailability
(c) Lack of processors
(d) Parallel data analysis

1-j. Parallel programming improves performance by:(CO5,K2) 1

(a) Running tasks concurrently
(b) Decreasing processor cores
(c) Using a single thread
(d) Avoiding task decomposition

2. Attempt all parts:-

2.a. Discuss the use of CUDA for GPU-based computing tasks.(CO1,K1) 2

2.b. Define decomposition in parallel computing.(CO2,K2) 2

2.c. Illustrate broadcast operation with 4 processors using MPI.(CO3,K3) 2

2.d. Compare mission-critical and business-critical systems in terms of tolerance to downtime.(CO4,K2) 2

2.e. Write the GCC compiler flag to compile an OpenMP program.(CO5,K2) 2

SECTION-B 30

3. Attempt all parts:-

3.a. Answer any one of the following:-

3.a.(i)	Illustrate the architecture of a typical high-performance computing system.(CO1,K2)	6
3.a.(ii)	Analyze the potential impact of quantum computing on cryptography.(CO1,K2)	6

3.b. Answer any one of the following:-

3.b.(i)	Illustrate SISD, SIMD, MISD, and MIMD with suitable real-life computing examples.(CO2,K2)	6
3.b.(ii)	Apply domain decomposition to solve a simple image processing problem.(CO2,K2)	6

3.c. Answer any one of the following:-

3.c.(i)	Construct a parallel prefix sum for array [2, 4,6, 8, 9].(CO3,K3)	6
3.c.(ii)	Apply graph partitioning to distribute an 8-node graph across 4 processors.(CO3,K3)	6

3.d. Answer any one of the following:-

3.d.(i)	Evaluate the role of clustering models in enhancing fault tolerance and scalability in distributed systems.(CO4,K1)	6
3.d.(ii)	Apply the concept of load-balancing clusters to a web-based application scenario.(CO4,K2)	6

3.e. Answer any one of the following:-

3.e.(i)	Describe the three major components of the OpenMP API with examples.(CO5,K3)	6
3.e.(ii)	Illustrate the general code structure of an OpenMP program in C/C++.(CO5,K3)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Design a real-world problem solution by applying computational thinking strategies.(CO1,K2)	10
4-b.	Assess the cost-benefit ratio of deploying HPC systems in academic research.(CO1,K2)	10

5. Answer any one of the following:-

5-a.	A parallel algorithm for computing the prefix sum of an array of size n=64 runs in $T_p=2\log_2(n)$ parallel steps when using 8 processors. A serial implementation of prefix sum takes Ts = n-1 steps. (a) Compute the serial execution time Ts (b) Compute the parallel execution time Tp (c) Compute the speed-up (CO2,K4)	10
5-b.	Explain the concepts of decomposition and mapping in parallel computing. Apply them to a simple example such as matrix multiplication.(CO2,K3)	10

6. Answer any one of the following:-

6-a.	Construct a distributed Breadth-First Search (BFS) algorithm using adjacency matrix representation.(CO3,K2)	10
6-b.	Integrate broadcast and reduction operations to design an efficient data aggregation strategy in a distributed environment.(CO3,K3)	10

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7. Answer any one of the following:-

7-a.	A company wants to set up a cluster for e-commerce transactions. Analyze whether it should choose Mission-critical or Business-critical architecture.(CO4,K3)	10
7-b.	Define Watch dog timers,Hearteat and Fault Recovery.(CO4,K2)	10

8. Answer any one of the following:-

8-a.	Explain the functions omp_set_num_threads() and omp_get_num_threads() with examples.(CO5,K3)	10
8-b.	Discuss the role of environment variables in debugging OpenMP programs and explain the two directives of OpenMP .(CO5,K3)	10