

MAHINDRA UNIVERSITY, HYDERABAD
École Centrale School of Engineering
End-semester Regular Examination
Program: B.Tech Branch: CAM Year:III
High-Performance Computing (MA3102)

Date:12-12-2024

Start Time:10:00 AM

Duration: 3 Hours

Max. Marks: 100

Instructions:

1. Open book examination. Students will be allowed to the exam with the textbook: "The Art of Multiprocessor Programming" by Maurice Herlihy and Nir Shavit, Morgan Kaufmann Publishers.
 2. Answer all questions in sequence.
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1. Assume that the time to perform an addition of two numbers is 1 unit. Estimate the time required to compute the addition of 1073741824 numbers under the following scenarios:

- (a) A single-core CPU: Determine the total time required.
- (b) A CPU with 16-cores: Estimate the time assuming the workload is evenly distributed among the cores and parallelized.
- (c) A GPU with 8192-cores: Evaluate the computation time under the assumption that the cores are fully utilized, with minimal overhead.

(CO1)(4+6+10 = 20 Marks)

2. You have the option to choose between a uni-processor that is capable of executing ten billion instructions per second and a 100-core processor, each core can execute one billion instructions per second. Discuss the factors and criteria you would evaluate to decide which processor to purchase for a specific application. Include considerations such as the nature of the workload and scalability.

(CO1)(20 Marks)

3. Given two vectors, each of length 10^8 , write a CUDA program to compute their dot product using 1024 threads per block. Optimize the algorithm to effectively utilize shared memory and minimize global memory access latency. Additionally, provide a detailed analysis of your approach, including its computational complexity, memory usage, and strategies to maximize GPU occupancy.

(CO2)(20 Marks)

4. Design and implement algorithms for the *contains()*, *insert()*, and *remove()* operations on a concurrent binary search tree, ensuring thread safety and optimized performance in multi-threaded environments. Also, describe how your algorithms maintain the correctness.

(CO2)(20 Marks)

5. Analyze and discuss the key factors that influence the performance of multi-threaded applications. Provide examples and strategies to mitigate performance bottlenecks in multi-threaded environments.

(CO3)(20 Marks)