

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL
MID-SEMESTER EXAMINATION, SEPTEMBER 2023
IT301: PARALLEL COMPUTING

Class: V SEM B.TECH. (IT)
Date: 26 /09/2023

Time: 1½ Hrs.
Marks: 50

Register No.

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NOTE: 1. Answer all questions

- (a) Describe Flynn's classification of computers based on instruction and data streams. Give an example for each.
(b) Distinguish between UMA and NUMA memory Models
[Marks : 5+5=10]
- (a) What are the advantages of Scalar processors? Consider a four stage pipeline with Fetch, Decode, execute and write back stages. With a necessary diagram explain how instructions are executed in pipeline based architecture.
(b) Assume that a program contains 500 instructions, and each pipeline stage takes one clock cycle time. Assuming four stage pipeline, compute the total number of cycles it may take for sequential execution and pipeline based parallel execution.
[Marks: 8+2=10]
- (a) Distinguish between shared memory and distributed memory parallel execution architecture.
(b) With an example, explain the following clauses of OpenMP.
(i) master (ii) single (iii) atomic
[Marks: 4+6=10]
- Consider that a structured block in OpenMP contains 100 iterations as follows.

```
for(i=0; i<100;i++)  
  a[i]=4*b[i]+3*c[i]+2*d[i]+e[i];
```

Consider the following type of scheduling and show the iterations assigned to each thread using Gantt Chart. Assume the number of threads as 4. write the explanation and show computation wherever necessary.

 - schedule(static, 20)
 - schedule(dynamic, 20) Thread request : 0 1 2 2 3
 - schedule(guided, 20) Thread request : 0 1 2 2 3

[Marks: 3+3+4=10]
- Consider image processing in computer graphics. Geometrical transformations on images are carried out by performing computation with respect to each pixel. Assume a 640 x 480 pixel black and white image needs to be translated and scaled. The image translation is performed based on computation $x_{new}[i]=x[i]+Tx$; and $y_{new}[i]=y[i]+Ty$; Similarly, an image is scaled by $x_{new}[i]=x[i] * Sx$ and $y_{new}[i]=y[i] * Sy$. Here, x_{new} and y_{new} are new pixel positions, $x[i]$ and $y[i]$ are current pixel values of an image, and Tx and Ty integer values for transformation. Sx and Sy are integer values as scaling a factor. Write an OpenMP parallel program to compute translation and scaling. Explain the logic used for executing the program in parallel.
[Marks: 6+4=10]

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NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Department of Information Technology
B.Tech (IT) V Semester-End Semester Examination, November 2023

Course Name: **Parallel Computing**

Date: **November 29, 2023**

Duration: **3 Hours**

Course Code: **IT30**

Time: **09:00 AM**

Max. Marks: **100**

Note:

- Your arguments should be convincing. Unnecessary details attracts penalty.
- Any notations used should be precisely defined.
- All programs should be readable.
- The question paper is of *three* pages.

1.
 - a) Write a MPI program to print "Hello World". Through this program, explain all essential parts of an MPI program. Also, explain the process of executing the program. (7)
 - b) Write a MPI program to determine the process ID of a process, as well as the number of processes that have been created. (6)
 - c) Consider the problem of computing the sum of the elements of a given array of n elements. Design a parallel algorithm to compute the sum. Write a MPI parallel program to compute the sum. (8)
 - d) Give two solutions to the deadlock problem that may arise with the use of synchronous send and receive calls of MPI. (4)
2.
 - a) With an example, explain the clauses firstprivate, lastprivate and collapse. (10)
 - b) With an example, describe how task level parallelism can be achieved using tasks in OpenMP. (10)
 - c) What are the challenges involved in a hybrid approach for parallelism such as combining MPI and OpenMP? What kind of applications more suits hybrid mode of parallel execution. (5)

3. a) Explain the following: (10)

- Thread object
- Condition variable
- Barrier
- Mutex
- Read write lock

b) What are the different types of mutexes available in pthread library? Explain the uses of those mutexes. (6)

4. a) What are the main challenges in programming a GPU?(4)

b) Describe the organization of the GPU kernel with an example.(4)

c) Write a CUDA program for matrix by vector multiplication.(7)

5. a) Choose all that are correct. Threads (1)

- A) supports software portability
- C) supports scheduling
- B) does not support latency hiding
- D) does not support load balancing

b) Programming models provide support for(1)

- A) Concurrency
- B) Synchronization
- C) Both A and B
- D) None of these

c) Lightweight processes and threads assume(1)

- A) all memory is local
- C) Both A and B
- B) all memory is global
- D) None of these

d) What are the qualifier keywords in function declarations in CUDA?(1)

- A) `--Kernel--`
- B) `--graphic--`
- C) `--global--`
- D) All of the above

e) A number of configuration parameters in the CUDA kernel function call.(1)

- A) 2
- B) 1
- C) 3
- D) 5

f) CUDA source file can have a mixture of (1)

- A) Host Code
- B) Device Code
- C) Both A & B
- D) None of these

g) Which is a form of parallelization which relies on splitting the computation by subdividing data across multiple processors.(1)

A) Data parallelism

C) Function parallelism

B) Task parallelism

D) Object parallelism

h) What is(are) true about variable types qualifier `__device__`? (1)

A) Resides in global memory (DRAM)

C) Is accessible from all the threads within the grid

B) Is accessible from the host through the runtime library

D) None of these

i) Assume that a kernel is launched with 1000 thread blocks each of which has 512 threads. If a variable is declared as a local variable in the kernel, how many versions of the variable will be created through the lifetime of the execution of the kernel?(2)

A) 1

B) 1000

C) 51200

D) 512000

j) For a vector addition, assume that the vector length is 4000, each thread calculates one output element, and the thread block size is 1024 threads. How many threads will be in the grid?(2)

A) 2000

B) 3000

C) 4096

D) 1024

6. Write an MPI/OpenMP program for odd-even sort algorithm and analyze for its parallel time complexity.(7)

*****All the Best*****