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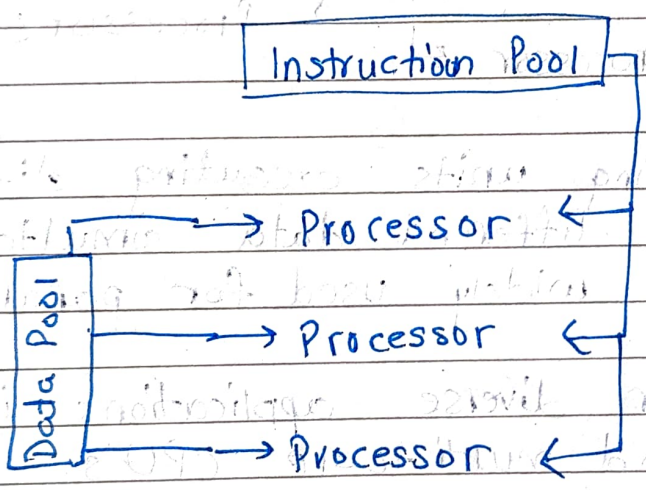
PC-23

HPC Theory Assignment

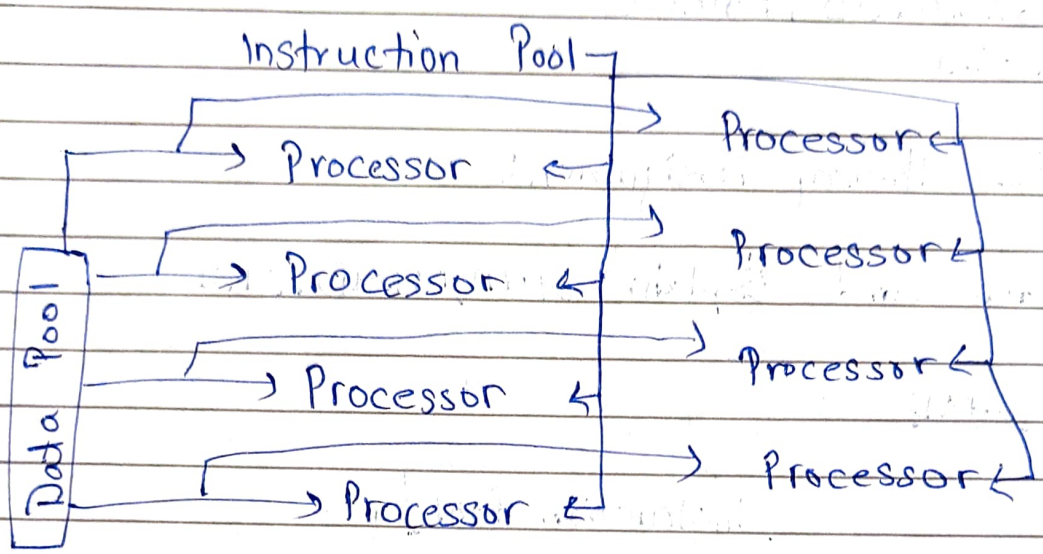
Q1) Draw and Explain SIMD, MIMD, SISD

→ 1) SIMD



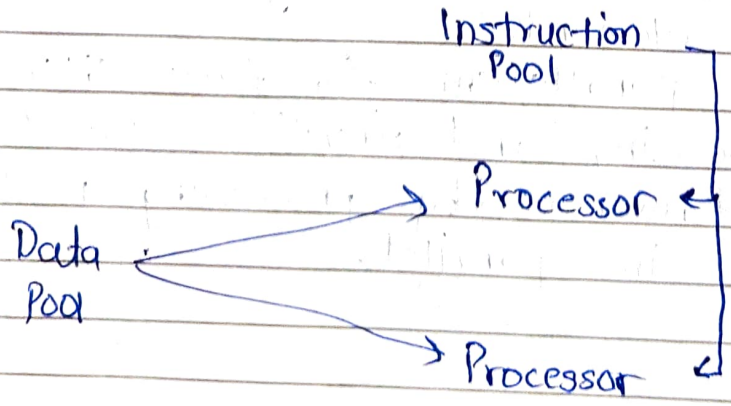
1) Simultaneous execution of a single instruction on multiple data elements.
2) Utilizes data parallelism for task like multimedia processing and scientific simulations.
3) Enhances performance by processing multiple data elements in parallel.

2) MIMD

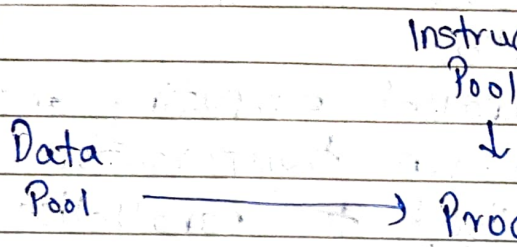


1) Multiple processing units executing diffn instructions on different data simultaneously.
2) Versatile and widely used for parallel computing tasks.
3) Scales well for diverse applications including HPC clusters and multi-core CPU's.

3) MISD

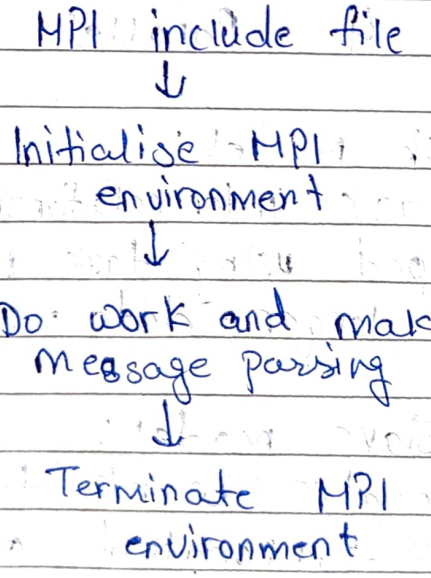


iv) SISD:



1) Sequential execution of instructions on a single piece of data at a time.
2) Traditional Von Neuman architecture with one processor executing instruction sequentially.
3) Not efficient for parallel computing due to its sequential nature.

Q2) Explain in detail the generic MPI program structure



1) MPI program start with initialization using 'MPI_init' to set up communication infra.
2) Communication between processes with 'MPI_Send & MPI_Recv'

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Q3) Explain odd-even transportation on bubble sort using parallel formulation.

→ In the context of parallel computing and bubble sort, the odd-even transportation algorithm can be utilised to parallelise the sorting processes as follows:

- Elements are compared pairwise and swapped
- Divide elements among processes initially
- Each process sorts its subset with merge sort / quicksort
- Execute multiple phases of odd even transposition.

Q4) Explain any 4 Parallel programming models.

→

1) Task Graph Model:
- Utilises task interrelationship
- Tasks mapped using task interaction graph.
- Used with larger data - computation ratios.

2) Master - Slave model:
- Master allocates work to slaves.
- Tasks pre-allocated or dynamically assigned.
- Care needed to avoid master bottleneck.
- Asynchrous interaction helps with workload balance.

3) Work-Pool model
- Dynamic task to process mapping for load balancing.
- Tasks can be performed by any processes.
- Centralised or decentralised mapping.

4) Pipeline / Producer - Consumer model
- Data stream passes through successive processes.
- Static mapping of tasks to processes.
- Granularity affects pipeline fill time and interaction overhead.

Q5) Explain the schemes of static mapping techniques for minimizing idling in parallel computing environment.

→ Schemes for static mapping:
1) Mapping based on data partitioning
- Divide data among processing units based on workload balance, data locality or communi-cation overhead.
Ex: block-cyclic distribution & scatter-gather strategies.

2) Hybrid Mapping:
- Hybrid mapping combines data and task partitioning.
- Optimizes resource units and minimizes idle time efficiently.