**Question 1: Shared Memory System**

**Given:**

* Floating-point operation time = 0.5 µs
* Memory access time per element = 1 µs

**a) Time taken by each processor**

Each element:

* 2 FP operations → 2×0.5=12 \times 0.5 = 1 µs
* Memory access time → 1 µs
* **Total time per element = 1 + 1 = 2 µs**

Each processor processes 4,000,000 elements:

* Time per processor = 4,000,000×2=8,000,0004,000,000 \times 2 = 8,000,000 µs = **8 seconds**

**b) Total parallel execution time**

Since all 4 processors work in parallel and there's ideal load balancing:

* **Total parallel execution time = 8 seconds**

**Question 2: Distributed Memory System**

**Given:**

* Floating-point operation time = 0.5 µs
* Memory access time = 0.1 µs
* Communication time per element = 0.2 µs
* Boundary exchange per node = 5000 elements

**a) Time taken by each node**

Each element:

* 2 FP ops → 2×0.5=12 \times 0.5 = 1 µs
* Memory access = 0.1 µs
* **Total time per element = 1 + 0.1 = 1.1 µs**

Each node processes 4,000,000 elements:

* Time per node = 4,000,000×1.1=4,400,0004,000,000 \times 1.1 = 4,400,000 µs = **4.4 seconds**

**b) Communication time per node**

Each node sends 5000 elements:

* Time = 5000×0.2=10005000 \times 0.2 = 1000 µs = **0.001 seconds**

**c) Total execution time**

Computation and communication are sequential:

* Total = **4.4 + 0.001 = 4.401 seconds**