**BE5-R3: PARALLEL COMPUTING**

**NOTE:**

1. **Answer question 1 and any FOUR from questions 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

**Time: 3 Hours** **Total Marks: 100**

**1.**

a) Draw a diagram for different types of memory architectures for building parallel, distributed, and cluster computers.

b) Discuss in brief various issues on cost-optimality of a parallel system.

c) Explain how parallel computer is differentiated from sequential computer.

d) Define network diameter. State the diameters of a Mesh, a Pyramid, and a Hypercube network.

e) Compare and contrast blocking communication call and non-blocking communication call.

f) What is shared memory? Discuss the advantages and disadvantages of shared memory in parallel computers.

g) Briefly describe store-and-forward communication.

**(7x4)**

**2.**

a) Define and explain the term `memory access` in the case of Parallel Random Access Machine (PRAM). Describe different types of `Concurrent Write (CW)` access to memory in PRAM.

b) Consider a sequence S of $n \geq 2$ values $\{x_1, x_2, \ldots \ldots, x_n\}$, as well as a datum x, are stored in the shared memory of a PRAM, and assume that $x \neq x_i$ for all i, $1 \leq i \leq n$. Write a parallel algorithm to compute the following: (i) If $x_i < x$ for all i, $1 \leq i \leq n$, then find the largest of the $x_i$'s. (ii) If $x_i > x$ for all i, $1 \leq i \leq n$, then find the smallest of all $x_i$'s. (iii) If some $x_i$ are smaller than x and some are larger, then find the average value of those smaller and the average value of those larger.

**(10+8)**

**3.**

a) Describe the diagrams for n = 8 in each case, how the `odd-even merging circuit` and the `odd-even-merge sorting circuit` operate. Compare the circuits in terms of their depth, width, and size.

b) Write a short note on `Memory Access Unit (MAU)` for the PRAM. Describe how an efficient MAU could be realized with the help of an odd-even merging circuit and an odd-even-merge sorting circuit.

**(9+9)**

**4.** Describe how rings and meshes can be embedded into hypercube containing $P = 2^d$ processors. Give the mapping of a 4×8 mesh into a 32-node hypercube.

**(18)**

**5.**

a) Define the term `speedup` of a parallel algorithm. State `speedup Folklore Theorem` and prove it.

b) State the `Folklore Theorem` related to the effect on running time of reducing the number of processors on a parallel computer, and prove it.

c) Define `efficiency` of a parallel algorithm. Comment on the following cases, when efficiency of a parallel algorithm is (i) less than one, (ii) equal to one, and (iii) greater than one.

**(6+7+5)**

**6.**

a) What is Amdahl's law? Suppose a program runs in 100 seconds on a machine with multiple operations responsible for 80% of the time. How much is it necessary to improve the speed of multiplication of the program is to be made to run 5 times faster.

b) "Latency reduction is generally a better idea than Latency tolerance" Comment on this statement with necessary justification.

c) Design a sequential (RAH) algorithms to solve the `Maximum Size Segment (MSS)` problem.

**(8+5+5)**

**7.**

a) Define `network topology`. Write short notes on the following topologies, and relatively compare them in terms of degree of a processor and longest distance between two processors: (i) Shuffle-exchange, (ii) Mesh of trees, and (iii) Cube-connected cycles.

b) Explain in detail Synchronous and Asynchronous message passing schemes of multi computers.

c) What is a race condition in the message passing parallel programs?

**(8+5+5)**