BE5-R3: PARALLEL COMPUTING

NOTE:

1. **Answer question 1 and any FOUR questions from 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) Discuss what is Efficiency of a parallel algorithm.

b) Describe a Memory Access Unit (MAU) that is required in operating a parallel random access machine (PRAM).

c) What are the different types of Concurrent Write access to memory in the case of a PRAM?

d) Define the term Speedup of a parallel algorithm and give one suitable example.

e) Briefly discuss the general characteristics of distributed memory model and mention its advantages and disadvantages.

f) Write a short note on a theoretically efficient parallel sorting circuit.

g) Briefly discuss different architectures for shared memory multiprocessing along with their advantages and disadvantages.

(7x4)

2.

a) What do you mean by parallel algorithm? Discuss merits and demerits of parallel computation. Mention the criteria for evaluating the goodness of a parallel algorithm.

b) When an algorithm is said to be asymptotically time optimal? Mention a problem for which we have a time optimal algorithm and justify your answer.

(9+9)

3.

a) What do you mean by network topology? Make assumptions that are usually incorporated while implementing a parallel algorithm in some interconnection network topology.

b) 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) Cube-connected cycles and (iii) Pyramid.

(9+9)

4.

a) Write a short note on de Bruijn network. Draw such an interconnection network for d = 2 and k = 3, when the number of processors $N = d^k$.

b) Write a short note on Star interconnection network and draw such a network for the number of processors N = 3!.

c) Design a cost-optimal algorithm for computing the prefix sums of n numbers on a PRAM, and justify whether the algorithm you have designed is cost-optimal.

(5+5+8)

5.

a) Discuss why is latency reduction generally a better idea than latency tolerance?

b) Suppose the links are 1 byte wide and operating at 300 MHz in a network where the average routing distance between nodes in $\log_4 P$ for P nodes. Compare the unloaded latency for 80-byte packets under store-and-forward and cut-through routing, assuming 4 cycles of delay per hop to make the routing decision and P ranging from 16 to 1,024 nodes. Perform the comparison for 32-KB transfer fragmented in 1-KB packets.

(6+12)

6.

a) Describe, how rings and meshes can be embedded into hypercube containing $P = 2^d$ processors.

b) Give the mapping of a 4×8 mesh into a 32-node hypercube.

(9+9)

7.

a) What is the PRAM model? Which PRAM model can be used to execute any other PRAM algorithm and how?

b) Compare the distributed memory model for parallel programming in terms of various parameters.

c) State the Maximum Sum Subsequence (MSS) problem. Design a sequential (RAM) algorithm to solve the problem.

(6+6+6)