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) Prove that a k-stage linear pipeline can be at most k times faster than that of a nonpipelined serial processor.
b) Briefly compare "Shared memory programming" and "message passing" paradigms on the basis of data sharing and synchronization.
c) What are the advantages and disadvantages of loop-splitting (statically dividing a loop among the processes) against self-seheduling?
d) Explain different architectures for shared memory multiprocessing along with its advantages and disadvantages.
e) Describe at least four characteristics of MIMD multiprocessors that distinguish them from multiple computer systems or computer networks.
f) Bitonic sequence is the basis of Bitonic merge sort. Justify.
g) A large multiprocessor usually allows a larger size of the problem to be undertaken in a reasonable execution time. Justify it using Gustafson's law.

(7x4)

2.

a) As a computational model how parallel programming differs from serial programming? What are advantages and disadvantages of explicit and implicit programming models?
b) Define speed up. What is the difference between fixed-size speed, fixed time speedup and memory-bounded speedup?

(9+9)

3.

a) Explain Micro benchmark for interconnection network of shared memory machines.
b) Which type of dependency is there in the following 'C' code? Using splittable loop concepts write the most efficient parallel code for the following in 'C'.

```
for(i=1;i<n;i++)
    {
     sum=0;
     for(j=1;j<n;j++)
           sum=sum+a[i][j]*x[j];
     x[i]=b[i]+c[i]*sum-a[i][i]*x[i];
    }
```

c) List various parallel programming models and explain various hybrid models in detail.

(6+6+6)

4.

a) Define Granularity. How it is useful in parallel computing. What is coarse grained and fine grained parallelism? Which one is the best?

b) Classify parallel computers based on Flynn's taxonomy in terms of streams of data and instructions. List other architectural classification schemes.

(8+10)

5.

a) What are the major performance metrics for characterizing an interconnection network?

b) Discuss P-RAM architecture in detail. What are the different subclasses of parallel model?

c) You are asked to design a data routing network for an SIMD array processor with 256 PEs. Barrel cyclic shifters are used to that a route from one PE to another requires only one unit of time per integers-power-of-two shift in either direction.

   i) Draw the interconnection barrel shifting network, showing all directly wired connections among the 266 PEs. In the drawing, at least one node (PE) must show all its connections to other PEs.

   ii) Calculate the minimum number of routing steps from any PE_i to any other PE_{i+k} for the arbitrary distance $1 \leq k \leq 255$. Indicate also the upper bound on the minimum routing steps required.

(2+6+10)

6.

a) Differentiate Asynchronous message passing and Synchronous message passing models.

a) Explain Butterfly network with its permutation. Give examples of some networks that can be categorized as butterfly network**.**

b) Explain quick sort using hypercube and discuss its efficiency.

(4+5+9)

7.

a) Discuss general characteristics of Distributed memory model. What are the advantages and disadvantages of this model?

b) Describe the master/slave programming paradigm. Discuss the role of synchronization, predictability and master/slave communication overhead with respect to the performance of programs based on the paradigm.

c) A network implements on property from each of the following three categories:

   i) circuit and packet switched
   ii) central and distributed control
   iii) synchronous and Asynchronous mode of operation

   Describe the implementations of all possible combinations.

(6+6+6)