

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) Differentiate and give definition of the following:
 - i) batch processing
 - ii) multiprogramming
 - iii) time sharing
 - iv) multiprocessing
- b) Differentiate functional programming model and logic programming model which are developed as language oriented models.
- c) What is the need of interconnection network? How does recirculating network function?
- d) Explain the applicability and the restriction involved in using the Amdahl's law, Gustafson's law and Sun and Ni's law to estimate the speedup performance of n processor system compared with that of a single processor system.
- e) Explain the salient features of CISC scalar processor.
- f) Compare the synchronous and asynchronous message passing system.
- g) List the name of different models developed for measuring the performance of parallel systems. Explain Gustafson's model in detail.

(7x4)

2.

- a) Elaborate the following terminologies associated with computers.
 - i) Barrel shifting functions
 - ii) Shuffle exchange functions
- b) Consider an n input Omega network where each switch cell is individually controlled and $N = 2^n$. Answer the following:
 - i) How many different permutations can be defined over n inputs?
 - ii) How many different permutations functions can be performed in one pass?
- c) Write an $(n \log_2 n)$ algorithm for Matrix multiplication.

(6+6+6)

3.

- a) Consider a multistage network. How many legitimate states are there in a 4X4 switch module including operation of broadcast and permutations? Justify your answer.
- b) Consider an 8 input Omega network using 2X2 switch modules in multiple stages. How many permutations can be implemented directly in a single pass through the network without blocking?
- c) Suppose 20% of the code of a program is found to be parallel and it can be executed simultaneously by 8 homogeneous processors. Rest of the code is sequential. The execution speed of processor is 8 MIPS.
 - i) calculate the effective MIPS rate of this program execution.

- ii) calculate the required amount of Parallel code to get effective MIPS rate as 20 MIS for same parameters.

(4+6+8)

4.

- a) What is the meaning of scalability of parallel algorithms? Write the characteristics of parallel algorithm written for PRAM machine.
- b) The following array is declared in FORTRAN 90.
REAL A(8,8,5)
REAL B(9,9)
REAL C(3,4,5)
- i) List array elements specified by following array expressions.
1) REAL A(6,7,*.*)
2) REAL C(*.*,3,4)
3) REAL B(6,*.*)
- ii) Can you make following array assignments:
1) A(3:5,7, *:6) = C(*,3,3:5)
2) C(*,4,4:5) = B(7:9, 8:9)
- c) Explain the term MPMD mode with respect to shared variable multiprocessor.

(6+8+4)

5.

- a) Consider the following loop
DO I = 1, N
 DO J = 2, N
 S1: A(I,J)=B(I,J)+C(I,J)
 S2: C(I,J)=D(I,J)/2
 S3: E(I,J)=A(I,J-1)**2+E(I,J-1)
 END DO
END DO
- i) Show the data dependency among statements.
ii) Show, how to parallelize the loop scheduling.
- b) Justify the requirements of Gigabit network technologies. Differentiate the following technologies and mention one application area of each one.
i) fiber channel and FDDI ring
ii) Past Ethernet and Gigabit Ethernet
- c) Elaborate salient features of parallel language and compilers with respect to control of parallelism and data parallelism.

(6+6+6)

6.

- a) What are various techniques used for optimization of parallel code. Apply instruction reordering technique to optimize following codes.
I1: Load R1, A
I2: Load R2, B
I3: Add R2, R1, R2 – delayed
I4: Load R3, C
- b) Define the following scalability metric parameters. Machine size, problem size, I/O demand, memory capacity and communication overhead.
- c) At 40 MHz processor was used to execute a benchmark program with following instructions mix and clock cycle count.

Instruction type	Instruction count	Clock cycle count
Integer arithmetic	45000	1
Data transfer	32000	2
Floating point	15000	2
Control transfer	8000	2

Determine the effective CPI, MIPS rate and execution time for this program.

(6+5+7)

7.

- a) What is meant by vectorization of code? Apply loop distribution technique to vectorize following code:

```
Do 10 I = 2, N
  B(I,1)=0
  Do 20 J = 1,M
    A(I) = A(I) + B(I,J) * C(I,J)
  20 Continue
  D(I)=E(I)+A(I)
10 Continue
```

- b) Explain following memory organization for vector access

- i) S access
- ii) C access
- iii) C/S access

(9+9)