UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 1997/98

September 1997

CSA401 - Parallel Processing

Duration : [3 hours]

INSTRUCTION TO CANDIDATE:

- Please ensure that this examination paper contains **FIVE** questions in **THREE** printed pages before you start the examination.
- Answer **ALL** questions. If you choose to answer the questions in English, at least one question must be answered in Bahasa Malaysia.

ENGLISH VERSION OF THE QUESTION PAPER

1. (a) Explain the following terms:

   (i) Parallelisation

   (ii) Speed-up

   (iii) Shared memory

   (6 marks)

   (b) Describe Flynn's classification of computer systems. Discuss each classification with examples of different types computer systems.

   (6 marks)

   (c) In a pipeline program with p processes, a sequence of n data values flows through the pipe line from beginning to end. Each process in the pipeline performs a transformation on each data value that requires T time units, and then sends it to the next process. The communication time between processes is C time units. The program ends when all the na data values have passed all the way through the pipeline. Assume that there is no process creation overhead. Derive an expression for the program execution time and the speedup.

   (8 marks)

2. (a) A parallel program with a sequential part of 10% is to be executed on a MIMD computer system. Is there a maximum achievable speedup, independent of the number of processors? Explain your answer.

   (4 marks)

   (b) A parallel program when executed on a SISD computer system takes 100 seconds. 2% of all commands of the program must be executed sequentially. 20% of all commands can be executed on 50 processors only. The rest can be executed on all available processors. What will be the time taken if it is executed on a MIMD computer with 100 processors?

   (10 marks)

   (c) What are virtual processors? Explain, with a simple example, the mapping of virtual processors onto the physical processors in an SIMD system.

   (6 marks)

3. (a) State the rigorous and simplified forms of data dependency rule for flow dependency. Explain with an example as to how the simplified form will affect the parallelisation.

   (8 marks)

   (b) What is a semaphore? What are the operations that can be performed on them? What are the actions taken by the system when those operations are executed on the semaphores?

   (8 marks)

   (c) Explain, with examples, the use of 'FORK' and 'JOIN' in parallel programming.

   (4 marks)

4. (a) Compare the connectivity, diameter and broadcasting time of the following topologies:

   (i) Hypercube

   (ii) 3D Mesh (size equal in all dimensions)

   (iii) 4D Mesh (size equal in all dimensions)

   (9 marks)

   (b) Show that a Line topology with 16 processors can be embedded into a Hypercube.

   (3 marks)

   (c) Given a multicomputer with the hypercube architecture of dimension 'n'. How many processors does it contain? How many additional processors are needed to make it a hypercube of dimension 'n+1'?

   (6 marks)

   (d) In a tree topology, the processors are connected in a binary tree pattern with the main processor 0 at the root of the tree. If there are n processors what is the diameter?

   (2 marks)

5. (a) Write a CSP process which will implement an integer semaphore which is to be shared among 100 processes.

   (6 marks)

   (b) Write a complete OCCAM program to sum n numbers using n transputers.

   (6 marks)

   (c) Develop a two-way merge sort algorithm for a mesh connected computer. Illustrate the execution of the algorithm by means of an example drawing the mesh rows and columns.

   (8 marks)

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