UNIVERSITI SAINS MALAYSIA

Supplementary Examination
Academic Session 1997/98

April 1998

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) Describe Flynn's classification of computer systems. Discuss as to how various types of parallel computer systems fit into the classification.

(8 marks)

(b) Consider a general form of pipeline program, in which a long sequence of data values continues to flow through the pipeline from beginning to end. In this general pipeline, different types of operations may be performed by different processes. Assume that the specific operation performed by each process i requires T_i time units. Let process k be the one with the largest such time. Explain, with suitable timing sketches why the time T_k limits the performance of the pipeline, even if all the other T_i are much less than T_k.

(4 marks)

(c) State and explain Amdahl's law.

(4 marks)

(d) A parallel program is to be executed on a MIMD computer with 100 processors. However, 3% of all instructions during program execution must be carried out sequentially, but the rest can be executed in all processors in parallel. What is the speedup of this program on this computer?

(4 marks)

2. (a) What are the important parameters that characterise the multicomputer topology? How do these parameters influence the cost and the performance of the multicomputer?

(4 marks)

(b) Discuss the hypercube interconnection topology.

(6 marks)

(c) Just as a 2-D mesh can be enhanced to a Torus topology, 3-D mesh can also be enhanced. What is the connectivity and diameter of such an enhanced 3-D Mesh with n processors? Explain your answer.

(6 marks)

(d) Show that mesh topology can be embedded in hypercube topology.

(4 marks)

3. (a) Explain, with the help of sketches, the control driven, data driven and demand driven parallel computation model.

(6 marks)

(b) 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.

<div align="right">(6 marks)</div>

(c) Determine all the data dependencies with the directions and draw the data dependency graph for the following segment of the program:

```
For I := 1 to n Do
    A[i] := B [i] + D[i+1]
    B[i] := D[i-1]+1
    C[i] := A[i-1] +B [i+1]
    D[i] :=  15
end
```

(8 marks)

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

(6 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?

(10 marks)

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

(4 marks)

5. (a) Write a complete OCCAM program to sum all the elements of a matrix. Assume that any number of transputers are available.

(6 marks)

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

(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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