

UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 1996/97

October/November 1996

**CSA401 - Parallel Processing**

Duration : [3 hours]

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**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.
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ENGLISH VERSION OF THE QUESTION PAPER

1. (a) What are the important parameters that characterize the multicomputer topology? How do these parameters influence the cost and the performance of the multicomputer?  
(4 marks)
- (b) 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)
- (c) 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)
- (d) 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 ' $n+1$ '?  
(4 marks)
- (e) Describe the steps to connect the additional processors in (d) above to increase the dimension of the hypercube to ' $n+1$ '?  
(4 marks)
2. (a) State and derive Amdhal's law.  
(4 marks)
- (b) A vector of length  $n$  is processed by (i) Serial (ii) Pipe Line and (iii) Parallel Computer. Derive the expressions for processing the vectors in each one of the computers and sketch the variation of their performance with the size of the vector.  
(8 marks)
- (c) In the light of Amdhal's law, explain why it is important for multiprocessor systems to have specially designed high-bandwidth disk I/O systems.  
(3 marks)
- (d) A parallel program is to be executed on a SIMD computer with 50,000 PEs.  
However,  
10% of all instructions executed are scalar,  
5% of all instructions can only be executed vectorially on 1,000PEs,  
35% of all instructions can only be executed vectorially on 40,000PEs,  
the rest can be executed vectorially on all PEs.  
What is the speedup of this program for this computer system?  
(5 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 parallelization. (6 marks)

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

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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

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(8 marks)

4. (a) 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)

- (b) A database may be used either for reading or writing. Any number of users may read from it simultaneously, but any user who is writing must have exclusive access to the database. whenever, a writer is ready to use the database, he should be allowed to do so as soon as possible. Construct a solution to this problem using critical regions and semaphores. (6 marks)

- (c) Solve the problem in (b) above using Monitor construct. (6 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) Write an SIMD procedure to find the root of a nonlinear equation. Explain the algorithm used. (8 marks)