

OLLSCOIL NA hÉIREANN, GAILLIMH  
NATIONAL UNIVERSITY OF IRELAND, GALWAY

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SUMMER EXAMINATIONS 2004

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B.Sc. Degree Examination

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CS428 - Advanced Operating Systems

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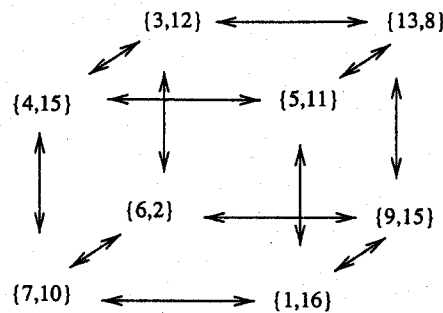
Time allowed: *two* hours.

Answer *three* questions.

1. (a) Determine the number of links, the diameter, and the bisection width of: (i) a  $k \times l$  torus network with  $kl$  nodes ( $k \geq l$ ), (ii) a binary tree network with  $\sum_{i=0}^d 2^i$  nodes.
- (b) Describe how a binary tree network with 15 nodes can be embedded into a  $5 \times 4$  mesh network. Describe how a  $4 \times 4$  torus network can be embedded into a hypercube network with 16 nodes. Give the dilation in each case.
- (c) State and prove Amdahl's Law.
- (d) Describe the Bucket Sort algorithm and calculate the speed-up obtained when the algorithm is implemented on  $m$  parallel processors. State any assumptions you use in your calculation.

(P.T.O.)

2. (a) The list {7, 10, 1, 16, 4, 15, 5, 11, 6, 2, 9, 15, 3, 12, 13, 8} has been distributed over an 8-processor hypercube network in the following manner.



Illustrate how a parallel Quicksort could be used to sort the list into increasing order.

- (b) Consider the system of two data-base transactions

$$T_1 = P_a V_a P_b P_c V_b V_c$$

$$T_2 = P_a P_d V_a P_b V_d P_c V_b V_c$$

expressed using Dijkstra's P-V notation. Represent the system graphically, and then determine: (i) any regions of deadlock, (ii) whether the system is safe, (iii) the serializable execution paths (up to homotopy), (iv) those execution paths (up to homotopy) that are not serializable, and (v) whether the system is two-phase locked.

- (c) Briefly explain why a system of two transactions is safe if it is two-phase locked.
3. (a) Write a brief note on the function *calloc()*, explaining how it can be used to dynamically create matrices.
- (b) Write a brief note on the shared memory calls *shmget()*, *shmat()* and *semget()*.
- (c) Compare and contrast the use of threads and heavyweight processes in a parallel implementation of a programme.
- (d) Describe how a Pthread is created and terminated.
4. (a) Write a brief note (with reference to an example) on the protection of a critical section by either a Pthread lock or a semaphore.
- (b) Prove that the  $N$ -point Fast Fourier Transform has a time complexity of  $O(N \log N)$ .
- (c) Give an application of the Discrete Fourier Transform in image processing. Describe a method for parallelisation of the Discrete Fourier Transform.