UNIVERSITY OF DUBLIN

TRINITY COLLEGE

Faculty of Engineering and Systems Sciences

Department of Computer Science

B.A.(Mod.) Computer Science — Trinity Term 2001

Junior Sophister Examination

3BA3 - Systems Software

Saturday 26th May — *RM. 3106/3126* — *09.30 - 12.30*

Dr. Ken Dawson-Howe

Attempt five questions, at least two questions from each section.

Section A – Operating Systems

1. Equal marks are given for each part of this question
   a. What are the main design principles behind the Windows NT and the UNIX operating systems?
   b. The Solaris 2 operating system uses kernel threads with which are associated one or no lightweight processes and these in turn are associated with one or more user level threads. Describe user level threads & kernel level threads, and indicate when each is more appropriate to be used (give sample situations).
   c. Compare and contrast the following UNIX IPC mechanisms in terms of synchronization, capacity, queuing mechanism, format, and addressing:
      - Shared Memory
      - Semaphores
      - Pipes
      - FIFOs
      - Signals
      - Message Queues

2. Part a) counts for 25%, part b) counts for 50% and part c) counts for 25%.
   a. Explain SJF scheduling (both preemptive and nonpreemptive).
   b. Determine the average waiting time under nonpreemptive SJF scheduling assuming $\alpha = 0.5$, $t_0 = 5ms$, $T_0 = 5ms$ for the following processes:

Process	First CPU burst	I/O burst	Second CPU burst
P_1	10 ms	1 ms	8 ms
P_2	5 ms	2 ms	5 ms
P_3	2 ms	10 ms	4 ms
P_4	5 ms	5 ms	8 ms

   c. Explain the significant of the 3 parameters α, t_0, T_0 and indicate the effect of increasing/decreasing their values.

3. Part a) counts for 30%, part b) counts for 40% and part c) counts for 30%.
   a. Explain how deadlock prevention works.
   b. Using the bankers' algorithm, evaluate if the following resource allocations should be allowed (or whether they will result in an unsafe state).

	Allocation	*Max*
	A B C	*A B C*
P_0	0 1 1	2 4 3
P_1	1 0 0	2 0 2
P_2	0 0 2	1 2 6
P_3	0 1 4	1 3 5
P_4	0 0 0	0 0 3

Note: There are three types of resources A, B, and C and there are 3, 5, and 9 of those resources respectively in total.

Suggested Allocations (Note that each of the allocations is to be applied to the system with the above resource state (the allocations are NOT one after the other):

i) a resource of type A to P_0
ii) a resource of type B to P_2
iii) a resource of type C to P_4

   c. Given
      - a 32 bit machine
      - a page size of 4K
      - a requirement each page table should fit into a single page
      - memory cycle time = 100ms
      - associate lookup time = 10ms
      - a required EAT of 120ms

   determine
      - the number of levels in the page table
      - the required hit ratio

4. Part a) counts for 30%, part b) counts for 50% and part c) counts for 20%.
   a. Explain the 3 main methods of interaction for I/O Systems.
   b. Compare the performance of the FCFS, SSTF and C-LOOK disk scheduling algorithms in terms of the total head movement. Assume that at any given time there are only 3 requests visible in the queue, that the head is initially at cylinder 0, and that the disk has 100 cylinders.

      Requests: 83, 20, 95, 50, 35, 4, 20, 92, 98, 6

   c. The largest security problem is not malicious programs! What is that threat and how can it be countered?

Section B – Data Communications

5. Equal marks are given for each part of this question
   a. Explain Nyquist's formula. Also, assuming that 32 discrete signal levels are being used, what would the capacity of a noise free telephone line be?
   b. Explain Shannon-Hartley's Law and assuming a S/N ratio of 35dB determine the capacity of typical telephone line.
   c. The second generation of cellular telephones used a combination of Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM). Explain both FDM and TDM and how they were employed in the 2^{nd} generation of cellular telephones.

6. Equal marks are given for each part of this question
   a. Explain the three ways in which digital data can be encoded on a sine wave carrier. Two of these characteristics are commonly used by modems and the possibilities are described using a constellation pattern. Indicate which two characteristics are used and a sample constellation pattern for either V.29 or V.32 modems.
   b. Explain character oriented framing and evaluate the efficiency of transmission assuming
      - a frame size of 100 characters
      - a single byte frame number
      - a byte of control information
      - a byte for an acknowledgement frame number
      - a 5 byte checksum
      - the DLE character has a probably of occurrence in the data of 10%.

7. Part a) counts for 30%, part b) counts for 30% and part c) counts for 40%.
   a. Explain how a cellular radio network can provide coverage of a large area by breaking the area into cells. Also how can the capacity of the network be increased in particular regions?
   b. How do the xDSL family of technologies propose to increase the data rate into the home? Explain this technology and include details of the communications problems that must be addressed when implementing it.
   c. Describe how the CRC algorithm works. Also with the generator 100011 determine the frame (incl. CRC) that should be transmitted for the following data: 100001111001011

8. Part a) counts for 40%, and part b) counts for 60%.
   a. Describe SLIP and PPP, and then compare & contrast them in terms of
      - framing
      - addressing
      - error detection
   b. Describe the 802.3 (CSMA/CD / Ethernet) standard in terms of
      - Network layout
      - Framing
      - Addressing
      - Error detection
      - Media Access (MAC) Protocol
        - Collision Detection
        - Truncated Binary Exponential Back-off algorithm