THE UNIVERSITY OF BIRMINGHAM

Degree of B.Sc. with Honours
Computer Science/Software Engineering, Second Examination.
Artificial Intelligence and Computer Science. Second Examination.

Joint Degree of B.Sc. with Honours

Degree of MSc in Computer Science.

06 02500
Operating Systems

May 2001   2 hours

[Answer ALL questions]
1. (a) Describe the possible states of a process and the transitions between them. [6%]

(b) Consider the following set of processes, with the length of the CPU-burst time given in milliseconds:

<table>
<thead>
<tr>
<th>Process</th>
<th>Burst Time</th>
<th>Priority</th>
<th>Arrival time</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_1$</td>
<td>10</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>$P_2$</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>$P_3$</td>
<td>2</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>$P_4$</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>$P_5$</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

The processes are assumed to have arrived in the order $P_1$ and $P_5$ at time 0 and $P_1$, $P_2$ and $P_3$ at time 1.5ms.

- Illustrate the execution of these processes using First-Come-First-Served, Shortest-Job-First, a non-preemptive priority (a smaller priority number implying a higher priority), and Round-Robin (quantum = 1ms) scheduling. When you have to decide which process runs, consider only the processes which are in the ready-queue at that time.
- What is the waiting time of each process for each of the above scheduling algorithms?
- Which of these schedules results in the minimal average waiting time (over all processes)? [15%]

2. (a) Define the working set of a process. [6%]

(b) You have devised a new page-replacement algorithm that you think may be optimal. In some contorted test cases, Belady’s anomaly occurs. Is the new algorithm optimal? Explain your answer. [6%]

(c) A multi-user system has been running with satisfactory performance so far. Now more users are added, and suddenly the performance decreases dramatically: the hard disk is in constant use, and response time has increased significantly. Give a possible cause for this behaviour and suggest a remedy. [8%]
3. (a) Explain the SCAN-algorithm for disk scheduling. [6%]
(b) When the average queue length is only one, all the disk-scheduling algorithms reduce to FCFS scheduling. Explain why this assertion is true. [5%]
(c) Why is it important to try to balance file system I/O among the disks and controllers on a system in a multitasking environment? [5%]

4. (a) Describe the bully algorithm for electing a new co-ordinator. [7%]
(b) Assume the network has become partitioned and is now reconnected. Does the Bully algorithm suffice to ensure that there is one co-ordinator in the new network? Justify your answer. [7%]
(c) Consider the following protocol:
   - Client asks Server for permission to do transaction;
   - Server grants permission if no Client currently executing transaction;
   - Client executes transaction;
   - Client tells Server completion of transaction.

Assume the server grants permission to only one client at a time. Does this schema ensure atomicity in the presence of client or server failures? Justify your answer. [7%]

5. (a) Describe UNIX file protection bits. [6%]
(b) A team is working on a software project. Team members have to have read access to all files created but only one team member should be able to modify a particular file at a time. This person should be able to transfer the permission to modify these files to someone else. The manager should have full control over all files. Describe how to implement such a system using access control lists and UNIX protection bits as far as possible. [10%]
(c) Capability lists are usually kept within the address space of the user. How does the operating system ensure that the user cannot modify the contents of the list? [6%]