Computer Science 3SH3 Michael Soltys

DAY CLASS
DURATION OF EXAMINATION: 2 Hours
MCMASTER UNIVERSITY FINAL EXAMINATION April 23, 2003

THIS EXAMINATION PAPER INCLUDES 3 PAGES AND 7 QUESTIONS. YOU ARE RESPONSIBLE FOR ENSURING THAT YOUR COPY OF THE PAPER IS COMPLETE. BRING ANY DISCREPANCY TO THE ATTENTION OF YOUR INVIGILATOR.

No aids allowed.

[20] 1. (a) What is a *virtual memory* and what is a *demand paging* algorithm?

(b) What is *Belady's Anomaly*? Which of the following paging algorithms suffer of Belady's Anomaly: FIFO, LRU, OPT? Which one is *infeasible* and why?

(c) Consider the following sequence of page requests:

$$\sigma = 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6$$

Compute $\mathrm{FIFO}(\sigma), \mathrm{LRU}(\sigma)$, and $\mathrm{OPT}(\sigma)$, for the following cache sizes: $3, 4$.

[20] 2. Suppose that the following processes arrive for execution at the times indicated. Each process will run the listed amount of time. In answering the question, use nonpreemptive scheduling and base all decisions on the information you have at the time the decision must be made.

| Process | Arrival Time | Burst Time |
|---|---|---|
| $P_1$ | 0.0 | 80 |
| $P_2$ | 2.4 | 45 |
| $P_3$ | 3.0 | 1 |

(a) What is the average turnaround time for these processes with the FCFS scheduling algorithm?

(b) What is the average turnaround time for these processes with the SJF scheduling algorithm?

(c) Explain the Round Robin CPU scheduling algorithm.

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[20] 3. Recall the *Bakery Algorithm* for $n$-process synchronization. The common data structures are: `boolean choosing[n]` and `int number[n]`, and the structure of process $P_i$ (for $0 \leq i \leq n-1$) is given by:

```
do {
   choosing[i]=true;
   number[i]=max{mumber[0],number[1],...,number[n-1]}+1;
   choosing[i]=false;
   for (j=0; j<n; j++) {
       while (choosing[j]);
       while ((number[j]!=0)&&((number[j],j)<(number[i],i)));
   }
       -- CRITICAL SECTION --
   number[i]=0;
       -- REMINDER SECTION --
   } while(1);
```

(a) Recall that $(a, b) < (c, d)$ if $a < c$ or if $a = c$ and $b < d$. Show that if process $P_i$ is in its critical section and $P_k$ ($k \neq i$) has *already* chosen its `number[k]!=0`, then `(number[i],i)<(number[k],k)`.

(b) Show that the condition of *mutual exclusion* is observed.

(c) Show that *progress* and *bounded-waiting* are also preserved.

[20] 4. Explain what are the following *system threats* :

(a) Trap Door

(b) Stack and Buffer Overflow

(c) Worms

(d) Viruses

(e) Denial of Service

[20] 5. You get a job as a system administrator of a large company. The company has a large network of Linux workstations (running RedHat 7.3). Your boss has the following requests: Install a good cryptographic protocol for encrypting email messages (the company is afraid of "industrial espionage"). How would you go about this assignment? Give some details.

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[20] 6. Deadlocks:

(a) Explain what are the *four* necessary conditions for a deadlock.

(b) Given a resource-allocation graph, what can we conclude about deadlocks in the system?

(c) There are *three* ways of dealing with deadlocks. Explain what they are, and what are their advantages/disadvantages.

(d) Describe *Banker's Algorithm*. In particular, make sure that you explain what are the following data structures: *Available*, *Max*, *Allocation*, *Need*.

[20] 7. Explain what is the *Dining-Philosopher's Problem*, and how to solve it using *semaphores*.

End of Exam