| CS 4760 | **Operating Systems** | Test 2 |
|---|---|---|
| Name: | Fall 2003 | Max Pts: 45 |

**Important**: This is an open book test. You can use any books, notes, or paper. *You are not allowed to use any communications device. Do not log into the computer during the test.* Any calculations and rough work can be done on the back side of the test pages. If there is a syntax error in any program segment, just write it down and you will get full credit for the problem. You will lose five points for not writing your name.

1. [5 pt] We said that certain operations should be performed by kernel to protect the system data structures. Yet, we also said that I/O is to be handled by kernel, knowing fully well that I/O does not modify any kernel data structures. What is the argument that requires us to do so?

2. [5 pt] What is the difference between process context and process mode? How do they differ from process [address] space?

3. [15 pt] Assume you have the following jobs to execute with one processor:

| Process | Burst time | Arrival time |
|---|---|---|
| $p_0$ | 9 | 0 |
| $p_1$ | 3 | 6 |
| $p_2$ | 3 | 9 |
| $p_3$ | 9 | 16 |
| $p_4$ | 8 | 17 |

Give the average wait time and average turnaround time for each process using the following algorithms. Is the CPU idle at any time in the given algorithms?

(a) First in first out

(b) Shortest job next (no preemption)

(c) Shortest remaining time next

(d) Round robin, with a quantum of 4

(e) Round robin, with a quantum of 5 plus context switch time of 1

4. [10 pt] Assume a system with five resource types, $C = \langle 9, 8, 9, 8, 11 \rangle$ (this is the total number of resources in the system, and not what is currently available), and the maximum claim table shown below.

| Process | $R_0$ | $R_1$ | $R_2$ | $R_3$ | $R_4$ |
|---|---|---|---|---|---|
| $p_0$ | 6 | 2 | 8 | 6 | 5 |
| $p_1$ | 7 | 4 | 9 | 4 | 6 |
| $p_2$ | 3 | 3 | 1 | 8 | 0 |
| $p_3$ | 3 | 5 | 6 | 2 | 5 |
| $p_4$ | 8 | 0 | 4 | 0 | 8 |

The resource allocator is considering allocating resources according to the following table:

| Process | $R_0$ | $R_1$ | $R_2$ | $R_3$ | $R_4$ |
|---|---|---|---|---|---|
| $p_0$ | 5 | 1 | 5 | 3 | 2 |
| $p_1$ | 0 | 1 | 4 | 3 | 1 |
| $p_2$ | 0 | 1 | 0 | 1 | 0 |
| $p_3$ | 0 | 4 | 0 | 1 | 1 |
| $p_4$ | 4 | 0 | 0 | 0 | 6 |

(a) Run the safety algorithm on this system to determine if this state is safe. If it is safe, give the sequence in which processes can be run. If it is unsafe, enumerate the processes that may get involved in a deadlock.

5. [4 pt] What is the difference between deadlock avoidance and deadlock prevention?

6. [6 pt] What is the advantage of late binding? What is the disadvantage?