CS 376	**Operating Systems**	Test 2
Name:	Winter 1999	Max Pts: 48

Important: This is an open book test. You can use any books, notes, or paper. *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. [15 pt] Assume you have the following jobs to execute with one processor:

Process	Burst time	Arrival time
p_0	80	10
p_1	25	30
p_2	15	20
p_3	20	30
p_4	45	0

Give the average wait time and average turnaround time for each process using the following algorithms:

(a) First in first out

(b) Shortest job next (decision to be made when a process is finished)

(c) Shortest remaining time next

(d) Round robin, with a quantum of 10

(e) Round robin, with a quantum of 10 plus context switch time of 2

2. [8 pt] Assume a system with four resource types, $C = \langle 6, 7, 12, 12 \rangle$, and the maximum claim table shown below.

Process	R_0	R_1	R_2	R_3
p_0	0	0	1	2
p_1	2	7	5	0
p_2	6	6	5	6
p_3	4	3	5	6
p_4	0	6	5	2

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

Process	R_0	R_1	R_2	R_3
p_0	0	0	1	2
p_1	2	0	0	0
p_2	0	0	3	4
p_3	2	3	5	4
p_4	0	3	3	2

Is this state safe? Why or why not?

3. [5 pt] Suppose in a system, a new process arrives at an average of 4 processes per minute and each such process requires an average of 12 seconds of service time. Estimate the fraction of time the CPU is busy in a system with a single processor.

4. [10 pt] Describe the algorithms for resolving the external references using the chain method and indirect addressing. Name at least one major difference between the two.

5. [10 pt] A system is composed of four processes $\{p_0, p_1, p_2, p_3\}$ and three types of consummable resources $\{R_0, R_1, R_2\}$. There is one unit each of R_0 and R_2 available.

- p_0 requests a unit of R_0 and a unit of R_2
- p_1 produces R_0 and R_2 and requests one unit of R_1
- p_2 requests one unit each of R_0 and R_2
- p_4 produces one unit of R_1 and requests a unit of R_2

Show the process resource graph to represent this system state.

Reduce the graph and determine which processes, if any, are deadlocked?