Important: This is an open book test. You can use any books, notes, or paper but no electronic device. *Do not log into the computer during the test, or use any electronic or communications device. Switch off your cell phones.* 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. [6 pt] When does a context switch take place? What happens during a context switch?

2. [10 pt] You are given the following set of processes.

Process	Memory	Burst time	Arrival time
p_0	200M	3	1
p_1	100M	5	6
p_2	600M	1	1
p_3	200M	4	4
p_4	600M	8	1

Using first fit strategy, show the placement of processes at time 0, 5, 10, 15, and 20. The total available memory is 1G.

3. [6 pt] Why is the resource allocation graph required to be a bipartite graph?

4. [10 pt] Assume a system with four resource types, $C = \langle 9, 10, 4, 14 \rangle$ (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
p_0	0	4	0	8
p_1	4	8	3	1
p_2	5	3	1	9
p_3	1	7	3	5
p_4	6	1	3	0

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	0	8
p_1	4	7	3	1
p_2	3	1	1	5
p_3	0	2	0	0
p_4	2	0	0	0

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.

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5. [15pt] Assume that you have the following jobs to be executed with one processor:

Process	Burst time	Arrival time
p_0	6	1
p_1	2	0
p_2	2	0
p_3	3	2
p_4	5	6

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 3

(e) Round robin, with a quantum of 3 plus context switch time of 1

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6. [6pt] Why cannot we do memory compaction in dynamically allocated memory in C programs?

7. [10pt] A machine has a memory of 64 frames, with each frame being 1K bytes. Current free-frame list is: 0x3F, 0x06, 0x08, 0x0D, 0x0A, 0x0C, 0x09, 0x07, 0x06, 0x2A, 0x0E, 0x32, and 0x0B. You just scheduled a process that requires 8 frames. Show the resulting page table. Show the translation of logical address 0x3941 and 0x0359 into physical addresses using your page table.