Homework 6

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Question 1.

Suppose that we have a multiprogrammed computer in which each job has identical characteristics. In one computation period T for a job, half the time is spent in I/O and the other half in processor activity. Each job runs for a total of N periods. Assume that a simple round-robin scheduling is used, and that I/O operations can overlap with processor operation. Define the following quantities:

- Turnaround time = actual time to complete a job
- Throughput = average number of jobs completed per time period T
- Processor utilization = percentage of time that the processor is active (not waiting)

Compute these quantities for one, two, and four simultaneous jobs, assuming that the period T is distributed in the following way: I/O first half, processor second half.

(a) One process

CPU			P1	P1			P1	P1	...
I/O	P1	P1			P1	P1			...

Turnaround time: N

Throughput: $\frac{N}{T}$

Utilization: 50%

(b) Two processes

CPU	P2	P2	P1	P1	P2	P2	P1	P1	...
I/O	P1	P1	P2	P2	P1	P1	P2	P2	...

Turnaround time: N

Throughput: $\frac{N}{T}$

Utilization: 100%

(c) Four processes

CPU	P4	P4	P1	P1	P2	P2	P3	P3	P4	P4	P1	P1	P2	P2	P3	P3	...
I/O	P1	P1	P2	P2	P3	P3	P4	P4	P1	P1	P2	P2	P3	P3	P4	P4	...

Turnaround time: $2N$

Throughput: $\frac{N}{T}$

Utilization: 100%

Question 2.

Consider the following workload:

Process	Burst Time	Arrival Time
P_1	10 ms	0 ms
P_2	20 ms	5 ms
P_3	50 ms	10 ms
P_4	30 ms	15 ms
P_5	10 ms	16 ms

Show the schedule using Shortest Remaining Time, Round Robin with time quantum of 10 ms, and Round Robin with time quantum of 20 ms. In addition, for each algorithm, state the turnaround and response times for each process.

Shortest Remaining Time

Time	Occurrence	Running	Queue
0	P_1 starts	P_1	
5	P_2 arrives	P_1	P_2
10	P_1 finishes	P_2	
10	P_3 arrives	P_2	P_3
15	P_4 arrives	P_2	P_4, P_3
16	P_5 arrives	P_5	P_2, P_4, P_3
26	P_5 finishes	P_2	P_4, P_3
40	P_2 finishes	P_4	P_3
70	P_4 finishes	P_3	
120	P_3 finishes		

Round Robin - TS 10 ms

Time	**Occurrence**	**Running**	**Queue**
0	P_1 starts	P_1	
5	P_2 arrives	P_1	P_2
10	P_1 finishes	P_2	
10	P_3 arrives	P_2	P_3
15	P_4 arrives	P_2	P_3, P_4
16	P_5 arrives	P_2	P_3, P_4, P_5
20	P_2 expires	P_3	P_4, P_5, P_2
30	P_3 expires	P_4	P_5, P_2, P_3
40	P_4 expires	P_5	P_2, P_3, P_4
50	P_5 finishes	P_2	P_3, P_4
60	P_2 finishes	P_3	P_4
70	P_3 expires	P_4	P_3
80	P_2 finishes	P_3	P_4
90	P_3 expires	P_4	P_3
100	P_4 finishes	P_3	
110	P_3 expires	P_3	
120	P_3 finishes		

Round Robin - TS 20 ms

Time	**Occurrence**	**Running**	**Queue**
0	P_1 starts	P_1	
5	P_2 arrives	P_1	P_2
10	P_1 finishes	P_2	
10	P_3 arrives	P_2	P_3
15	P_4 arrives	P_2	P_3, P_4
16	P_5 arrives	P_2	P_3, P_4, P_5
30	P_2 finishes	P_3	P_4, P_5
50	P_3 expires	P_4	P_5, P_3
70	P_4 expires	P_5	P_3, P_4
80	P_5 finishes	P_3	P_4
100	P_3 expires	P_4	P_3
110	P_4 finishes	P_3	
120	P_3 finishes		

Question 3.

Which type of process is generally favored by a multi-level feedback queueing scheduler — a process-bound process or an I/O-bound process? Briefly explain why.

An I/O-bound process is favored by an MLFQ scheduling algorithm, as CPU-bound processes are moved down in priority, while I/O-bound processes are moved to a higher queue.