Question 1

Consider the following four processes with arrival times (in milliseconds) and their length of CPU bursts (in milliseconds) as shown below:

Process	P1	P2	P3	P4
Arrival time	0	1	3	4
CPU burst time	3	1	3	Z

These processes are run on a single processor using pre-emptive Shortest Remaining Time First scheduling algorithm. If the average waiting time of the processes is 1 millisecond, then the value of Z is________.

Question 2

Consider the following CPU processes with arrival times (in milliseconds) and length of CPU bursts (in milliseconds) as given below:

Process	Arrival time	Burst time
P1	0	7
P2	3	3
P3	5	5
P4	6	2

If the pre-emptive shortest remaining time first scheduling algorithm is used to schedule the processes, then the average waiting time across all processes is _________ milliseconds.

Question 3

Consider the set of processes with arrival time (in milliseconds), CPU burst time (in milliseconds) , and priority (0 is the highest priority) shown below. None of the processes have I/O burst time.

Process	Arrival time	Burst Time	Priority
P1	0	11	2
P2	5	28	0
P3	12	2	3
P4	2	10	1
P5	9	16	4

The average waiting time (in milliseconds) of all the processes using pre-emptive priority scheduling algorithm is ____________

Question 4

Consider the following processes, with the arrival time and the length of the CPU burst given in milliseconds. The scheduling algorithm used is pre-emptive shortest remaining-time first.

Process	Arrival Time	Burst Time
P1	0	10
P2	3	6
P3	7	1
P4	8	3

The average turnaround time of these processes is milliseconds _________.

Question 5

Consider a uniprocessor system executing three tasks T_1, T_2 and T_3, each of which is composed of an infinite sequence of jobs (or instances) which arrive periodically at intervals of 3, 7 and 20 milliseconds, respectively. The priority of each task is the inverse of its period, and the available tasks are scheduled in order of priority, with the highest priority task scheduled first. Each instance of T_1, T_2 and T_3 requires an execution time of 1, 2 and 4 milliseconds, respectively. Given that all tasks initially arrive at the beginning of the 1^{st} millisecond and task preemptions are allowed, the first instance of T_3 completes its execution at the end of _______ milliseconds.

Question 6

For the processes listed in the following table, which of the following scheduling schemes will give the lowest average turnaround time?

Process	Arrival Time	Processing Time
A	0	3
B	1	6
C	4	4
D	6	2

- (A) First Come First Serve
- (B) Non – preemptive Shortest Job First
- (C) Shortest Remaining Time
- (D) Round Robin with Quantum value two

Question 7

Consider the following set of processes that need to be scheduled on a single CPU. All the times are given in milliseconds.

Process Name	Arrival Time	Execution Time
A	0	6
B	3	2
C	5	4
D	7	6
E	10	3

Using the *shortest remaining time first* scheduling algorithm, the average process turnaround time (in msec) is ______________________.

Question 8

Three processes A, B and C each execute a loop of 100 iterations. In each iteration of the loop, a process performs a single computation that requires tc CPU milliseconds and then initiates a single I/O operation that lasts for tio milliseconds. It is assumed that the computer where the processes execute has sufficient number of I/O devices and the OS of the computer assigns different I/O devices to each process. Also, the scheduling overhead of the OS is negligible. The processes have the following characteristics:

Process id	t_c	t_{io}
A	100 ms	500 ms
B	350 ms	500 ms
C	200 ms	500 ms

The processes A, B, and C are started at times 0, 5 and 10 milliseconds respectively, in a pure time sharing system (round robin scheduling) that uses a time slice of 50 milliseconds. The time in milliseconds at which process C would *complete* its first I/O operation is ____________.

Question 9

An operating system uses *shortest remaining time first* scheduling algorithm for pre-emptive scheduling of processes. Consider the following set of processes with their arrival times and CPU burst times (in milliseconds):

Process	Arrival Time	Burst Time
P1	0	12
P2	2	4
P3	3	6
P4	8	5

The average waiting time (in milliseconds) of the processes is _________.

Question 10

A scheduling algorithm assigns priority proportional to the waiting time of a process. Every process starts with priority zero (the lowest priority). The scheduler re-evaluates the process priorities every *T* time units and decides the next process to schedule. Which one of the following is TRUE if the processes have no I/O operations and all arrive at time zero?

- (A) This algorithm is equivalent to the first-come-first-serve algorithm.
- (B) This algorithm is equivalent to the round-robin algorithm.
- (C) This algorithm is equivalent to the shortest-job-first algorithm.
- (D) This algorithm is equivalent to the shortest-remaining-time-first algorithm.

Question 11

Consider the 3 processes, P1, P2 and P3 shown in the table.

Process	Arrival time	Time Units Required
P1	0	5
P2	1	7
P3	3	4

The completion order of the 3 processes under the policies FCFS and RR2 (round robin scheduling with CPU quantum of 2 time units) are:

- (A) FCFS: P1, P2, P3 RR2: P1, P2, P3
- (B) FCFS: P1, P3, P2 RR2: P1, P3, P2
- (C) FCFS: P1, P2, P3 RR2: P1, P3, P2
- (D) FCFS: P1, P3, P2 RR2: P1, P2, P3

Question 12

Consider the following table of arrival time and burst time for three processes P0, P1 and P2.

Process	Arrival time	Burst Time
P0	0 ms	9 ms
P1	1 ms	4 ms
P2	2 ms	9 ms

The pre-emptive shortest job first scheduling algorithm is used. Scheduling is carried out only at arrival or completion of processes. What is the average waiting time for the three processes?

- (A) 5.0 ms
- (B) 4.33 ms
- (C) 6.33 ms
- (D) 7.33 ms

Question 13

Consider three process, all arriving at time zero, with total execution time of 10, 20 and 30 units respectively. Each process spends the first 20% of execution time doing I/O, the next 70% of time doing computation, and the last 10% of time doing I/O again. The operating system uses a shortest remaining compute time first scheduling algorithm and schedules a new process either when the running process gets blocked on I/O or when the running process finishes its compute burst. Assume that all I/O operations can be overlapped as much as possible. For what percentage of does the CPU remain idle?

Question 14

Consider the set of 4 processes whose arrival time and burst time are given below-

Process No.	Arrival Time	Burst Time		
		CPU Burst	I/O Burst	CPU Burst
P1	0	3	2	2
P2	0	2	4	1
P3	2	1	3	2
P4	5	2	2	1

If the CPU scheduling policy is Shortest Remaining Time First, calculate the average waiting time and average turnaround time.

Question 15

Consider the set of 4 processes whose arrival time and burst time are given below-

Process No.	Arrival Time	Priority	Burst Time		
			CPU Burst	I/O Burst	CPU Burst
P1	0	2	1	5	3
P2	2	3	3	3	1
P3	3	1	2	3	1

If the CPU scheduling policy is Priority Scheduling, calculate the average waiting time and average turnaround time. (Lower number means higher priority)