# DPP

## Operating System

## CPU Scheduling

**Q1** Consider the following process scenario.

| Process | Arrival Time (in milliseconds) | Burst Time (In milliseconds) |
|---|---|---|
| P1 | 4 | 5 |
| P2 | 5 | 3 |
| P3 | 8 | 4 |
| P4 | 7 | 2 |
| P5 | 3 | 1 |
| P6 | 0 | 6 |
| P7 | 7 | 2 |

The average waiting time of processes for FCFS scheduling algorithm is _____ milliseconds?

**Q2** Consider the following process scenario.

| Process | Arrival Time (in milliseconds) | Burst Time (In milliseconds) |
|---|---|---|
| P1 | 5 | 6 |
| P2 | 3 | 3 |
| P3 | 1 | 4 |
| P4 | 2 | 2 |
| P5 | 4 | 1 |
| P6 | 0 | 3 |
| P7 | 1 | 2 |

The average waiting time processes for non-preemptive shortest job first scheduling algorithm is _____ milliseconds (rounded up to 2 decimal places)?

**Q3** Consider a CPU performance metric throughput which is calculated as:

$$Throughput = \frac{Number\ of\ processes\ executed}{Total\ scheduling\ duration\ from\ first\ process\ arrival\ till\ last\ process\ completion}$$

For the following process scenario calculate the throughput calculated for non-preemptive SJF algorithm ____ per milliseconds (rounded up to 1 decimal place)?

| Process | Arrival Time (in milliseconds) | Burst Time (in milliseconds) |
|---|---|---|
| P1 | 0 | 3 |
| P2 | 4 | 6 |
| P3 | 7 | 4 |
| P4 | 9 | 2 |
| P5 | 8 | 1 |
| P6 | 6 | 3 |

**Q4** Consider a CPU performance metric throughput which is calculated as:

$$Throughput = \frac{Number\ of\ processes\ executed}{Total\ scheduling\ duration\ from\ first\ process\ arrival\ till\ last\ process\ completion}$$

For the following process scenario calculate the throughput calculated for FCFS algorithm as x and for non-preemptive SJF scheduling as y. The value of x – y is _____?

| Process | Arrival Time | Burst Time |
|---|---|---|
| P1 | 0 | 4 |
| P2 | 0 | 3 |
| P3 | 0 | 1 |
| P4 | 0 | 5 |

**Q5** Consider 4 processes A, B, C and D. All arrived at time 0 in the given order. The processes needed 5ns, 3ns, 9ns and 10ns respectively for their CPU burst to complete. The average turnaround time of processes if executed in FCFS order is _____ns (rounded up to 2 decimal place)?

**Q6** Four processes to be executed on a single processor system arrives at time 0+ in the order A, B, C and D. Their CPU burst time requirements are 4, 1, 6, 2 time units respectively. The completion time of processe A under Round-Robin scheduling with time slice of one time unit is _____?

**Q7** On a system using round robin CPU scheduling, context-switch overhead is given by 's'. Time quantum is 'q'. The CPU efficiency, if q=s is?

(A) 50%

(B) Zero

(C) 100%

(D) Not predictable

**Q8** Consider the following process scenario.

| Process | Arrival Time (in milliseconds) | Burst Time (In milliseconds) |
|---|---|---|
| P1 | 0 | 12 |
| P2 | 1 | 8 |
| P3 | 2 | 7 |
| P4 | 3 | 2 |
| P5 | 7 | 3 |

The average waiting time processes for preemptive shortest remaining time first scheduling algorithm is _____ milliseconds (rounded up to 1 decimal place)?

**Q9** Consider the following process scenario.

| Process | Arrival Time (in milliseconds) | Burst Time (In milliseconds) |
|---|---|---|
| P1 | 0 | 8 |
| P2 | 1 | 4 |
| P3 | 2 | 1 |
| P4 | 4 | 5 |

The average waiting time processes for round robin scheduling algorithm is _____ milliseconds with time slice of 3 milliseconds (rounded up to 1 decimal place)?

**Q10** A computer system has 2GB of RAM and OS occupies 256MB of RAM. All the user processes are of 128MB and have same characteristics. If the goal is 99% CPU utilization, then the maximum I/O wait that can be tolerated is _____% (rounded to nearest integer)?

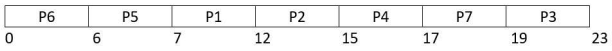
# Answer Key

| | |
|---|---|
| Q1 | 6~6 |
| Q2 | 4~5 |
| Q3 | 0.3~0.3 |
| Q4 | 0~0 |
| Q5 | 14.25~14.25 |
| Q6 | 10~10 |
| Q7 | (A) |
| Q8 | 7.4~7.4 |
| Q9 | 7.5~7.5 |
| Q10 | 72~72 |

# Hints & Solutions

**Q1 Text Solution:**

The gantt chart for the execution of the processes will be as follows:



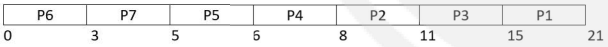

The completion time, turn around time and waiting time of processes are as follows:

| Process | Arrival Time | Burst Time | Completion Time | Turn around time | Waiting Time |
|---|---|---|---|---|---|
| P1 | 4 | 5 | 12 | 8 | 3 |
| P2 | 5 | 3 | 15 | 10 | 7 |
| P3 | 8 | 4 | 23 | 15 | 11 |
| P4 | 7 | 2 | 17 | 10 | 8 |
| P5 | 3 | 1 | 7 | 4 | 3 |
| P6 | 0 | 6 | 6 | 6 | 0 |
| P7 | 7 | 2 | 19 | 12 | 10 |

Average waiting time = (3+7+11+8+3+0+10)/7 = 42/7 = 6

**Q2 Text Solution:**

The gantt chart for the execution of the processes will be as follows:




The completion time, turn around time and waiting time of processes are as follows:

| Process | Arrival Time | Burst Time | Completion Time | Turn around time | Waiting Time |
|---|---|---|---|---|---|
| P1 | 5 | 6 | 21 | 16 | 10 |
| P2 | 3 | 3 | 11 | 8 | 5 |
| P3 | 1 | 4 | 15 | 14 | 10 |
| P4 | 2 | 2 | 8 | 6 | 4 |
| P5 | 4 | 1 | 6 | 2 | 1 |
| P6 | 0 | 3 | 3 | 3 | 0 |
| P7 | 1 | 2 | 5 | 4 | 2 |

Average waiting time = (10+5+10+4+1+0+2)/7 = 32/7 = 4.57

**Q3 Text Solution:**

Here when first process will be scheduled at 0 to execute then it will complete till 3 milliseconds. After that there will not be any process in ready state for 1 millisecond till 4 milliseconds. Hence for 1 millisecond the CPU will be idle. After that all processes will run one after another according to algorithm without any idle period.

Total execution time = 3 + 6 + 4 + 2 + 1 + 3 = 19

Total execution time including idle period = 19 + 1 = 20

Throughput = 6/20 = 0.3

**Q4 Text Solution:**

Total burst time = 4 + 3 + 1 + 5 = 13

All processes are arriving at 0 hence all algorithms will have scheduling length = 13 – 0 = 13

Hence for all algorithms throughput = 4 / 13

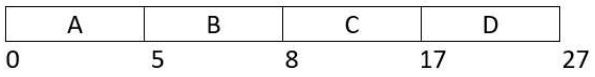
Hence x = 4/13,

Also y = 4/13

Hence, x – y = 0

**Q5 Text Solution:**

The gantt chart for the execution of the processes will be as follows:




The completion time and turn-around time of processes are as follows:

| Process | Arrival Time | Burst Time | Completion Time | Turn around time |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| A | 0 | 5 | 5 | 5 |
| B | 0 | 3 | 8 | 8 |
| C | 0 | 9 | 17 | 17 |
| D | 0 | 10 | 27 | 27 |

Average turn-around time = (5 + 8 + 17 + 27) /4 = 57/4 = 14.25

**Q6 Text Solution:**

The Gantt chart for the execution of the processes will be as follows:


Process A completes at time 10.

**Q7 Text Solution:**

CPU efficiency is only when process executes, hence

$Efficiency = \frac{q}{q+s} * 100\%$

For q = s

Efficiency = 50%

**Q8 Text Solution:**

The Gantt chart for the execution of the processes will be as follows:

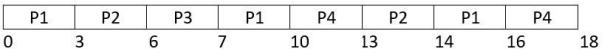

The completion time, turn-around time and waiting time of processes are as follows:

| Process | Arrival Time | Burst Time | Completion Time | Turn around time | Waiting Time |
|---|---|---|---|---|---|
| P1 | 0 | 12 | 32 | 32 | 20 |
| P2 | 1 | 8 | 14 | 13 | 5 |
| P3 | 2 | 7 | 21 | 19 | 12 |
| P4 | 3 | 2 | 5 | 2 | 0 |
| P5 | 7 | 3 | 10 | 3 | 0 |

Average waiting time = (20+5+12+0+0)/5 = 7.4

**Q9 Text Solution:**

The Gantt chart for the execution of the processes will be as follows:




The completion time, turn-around time and waiting time of processes are as follows:

| Process | Arrival Time | Burst Time | Completion Time | Turn around time | Waiting Time |
|---|---|---|---|---|---|
| P1 | 0 | 8 | 16 | 16 | 8 |
| P2 | 1 | 4 | 14 | 13 | 9 |
| P3 | 2 | 1 | 7 | 5 | 4 |
| P4 | 4 | 5 | 18 | 14 | 9 |

Average waiting time = (8+9+4+9)/4 = 30/4 = 7.5

**Q10 Text Solution:**

From 2GB RAM if space for OS is removed then in remaining space only the user processes will be allocated.

Total available RAM = 2GB

OS occupied RAM = 256MB

User process = 128MB

Hence number of user processes (n) = (2GB – 256MB) / 128MB

= 16 – 2

= 14

For IO wait p and number of processes n,

CPU utilization = $1 - p^n$

$0.99 = 1 - p^{14}$

p = 0.719686 = 72%