Tutorial 4 solution

1. In a system using single processor, a new process arrives at the rate of six processes per minute and each such process requires seven seconds of service time. What is the CPU utilization?
   a. 70%
   b. 30%
   c. 60%
   d. 64%

   Sol:

   Number of processes per minute = 6
   Burst time of each process = 7 sec
   CPU utilization within a minute = 6*7 = 42 sec
   % CPU utilization = (useful time / total time) *100
   = (42/60)*100
   = 70%
2. Five jobs A, B, C, D and E are waiting in Ready Queue. Their expected runtimes are 9, 6, 3, 5 and 4 respectively. All jobs entered in Ready queue at time zero. They must run in _____ order to minimize average waiting time.
   a. B, A, D, E, C
   b. C, E, D, B, A
   c. E, D, C, B, A
   d. C, B, A, E, D

   Sol:

We will solve it by minimizing the avg Waiting Time and Take x = 4 BT = Burst or Execution time CT = completion time P = Process AWT = Average Waiting Time AT = Arrival time WT = Waiting time

			Option A		Option B		Option C		Option D	
P	AT	BT	CT_A	WT_A	CT_B	WT_B	CT_C	WT_C	CT_D	WT_D
A	0	9	15	6	27	18	27	18	18	9
B	0	6	6	0	18	12	18	12	9	3
C	0	3	27	24	3	0	12	9	3	0
D	0	5	19	14	12	7	9	4	27	22
E	0	4	23	19	7	3	4	0	22	18
				63/5		40/5		43/5		52/5
				AWT=12.6		AWT=8		AWT=8.6		AWT=10.4

We get minimum average waiting time from the sequence given in option (B)

3. Consider a uniprocessor system executing three tasks T1, T2 and T3, 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 T1, T2 and T3 requires an

execution time of 1, 2 and 4 milliseconds, respectively. Given that all tasks initially arrive at the beginning of the 1st milliseconds and task pre-emptions are allowed, the first instance of T3 completes its execution at the end of _____ milliseconds.

a. 5
b. 10
c. 12
d. 15

Sol:

Periods of T1, T2 and T3 are 3ms, 7ms and 20ms. Since priority is inverse of period, T1 is the highest priority task, then T2 and finally T3. Every instance of T1 requires 1ms, that of T2 requires 2ms and that of T3 requires 4ms. Initially all T1, T2 and T3 are ready to get processor, T1 is preferred. Second instances of T1, T2, and T3 shall arrive at 3, 7, and 20 respectively. Third instance of T1, T2 and T3 shall arrive at 6, 14, and 40 respectively.

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Time-Interval  Tasks
 0-1           T1
 1-2           T2
 2-3           T2
 3-4           T1  [Second Instance of T1 arrives]
 4-5           T3
 5-6           T3
 6-7           T1  [Third Instance of T1 arrives]
                   [Therefore T3 is preempted]
 7-8           T2  [Second instance of T2 arrives]
 8-9           T2
 9-10          T1  [Fourth Instance of T1 arrives]
10-11          T3
11-12          T3 [First Instance of T3 completed]
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4. Consider three CPU-intensive processes, which require 10, 20 and 30 time units and arrive at times 0, 2 and 6, respectively. How many context switches are needed if the operating system implements a shortest remaining time first scheduling algorithm? Do not count the context switches at time zero and at the end.

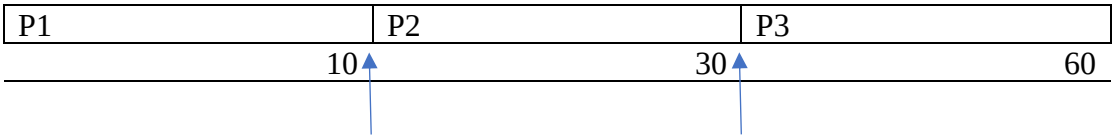
a. 1
b. 2
c. 3
d. 4

Sol:

PID	Arrival Time	Burst Time
P1	0	10

P2	2	20
P3	6	30

GANTT chart



5. Consider three processes, 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 time does the CPU remain idle?
   a. 0%
   b. 10.6%
   c. 30.0%
   d. 89.4%

   Sol:

PID	AT	IO	BT	IO
P1	0	2	7	1
P2	0	4	14	2
P3	0	6	21	3

```
 idle   p0    p1     p2    idle
0    2     9     23     44     47

Total time spent = 47
Idle time = 2 + 3 = 5
Percentage of idle time = (5/47)*100 = 10.6 %
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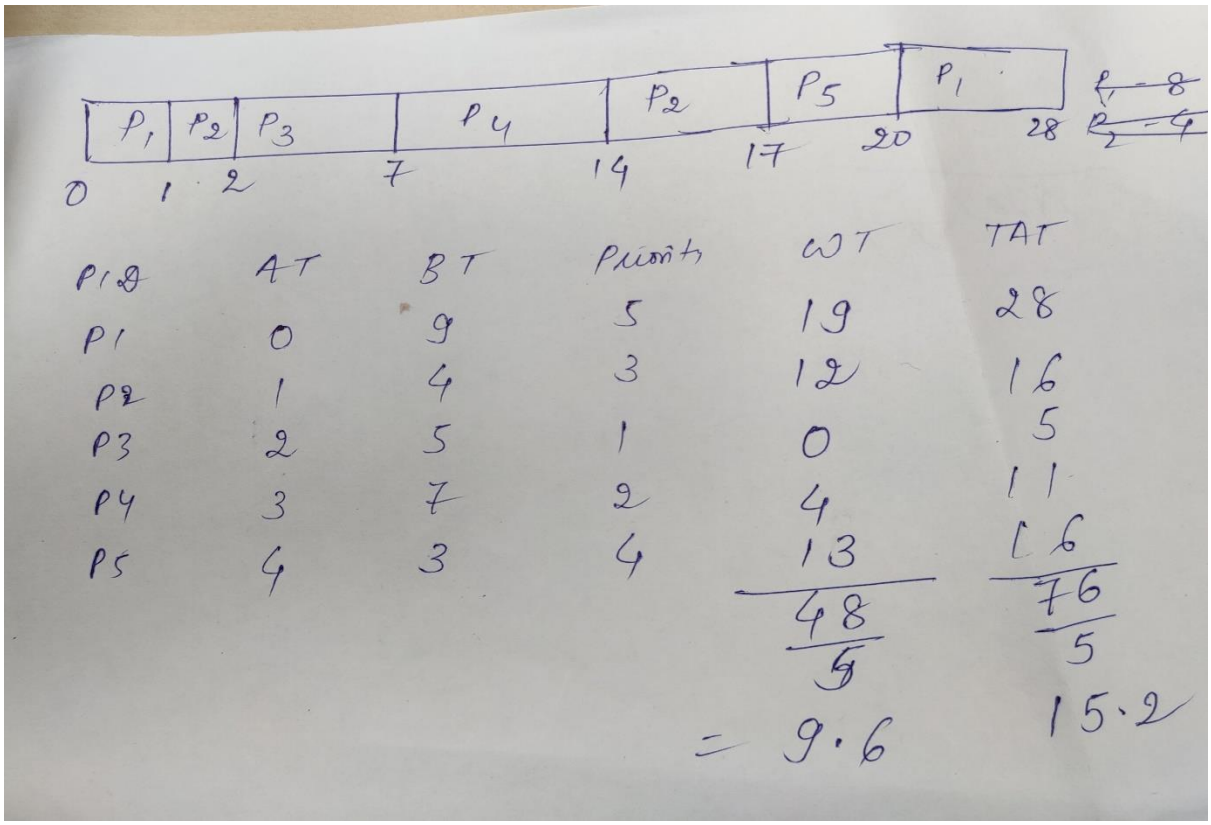
6. Consider the following processes and their CPU burst time and find out average waiting time and average turnaround time using pre-emptive form of priority scheduling algorithm (Lower number represents higher priority).

Process	Burst Time (mills.)	Priority	Arrival Time (mills)
P1	9	5	0
P2	4	3	1
P3	5	1	2
P4	7	2	3
P5	3	4	4
Total	28		

Sol:



P.ID	AT	BT	Priority	WT	TAT
P1	0	9	5	19	28
P2	1	4	3	12	16
P3	2	5	1	0	5
P4	3	7	2	4	11
P5	4	3	4	13	16
				48	76
				5	5
				= 9.6	15.2