Q. 1

- Discuss how the following pairs of scheduling criteria conflict in certain settings.
  - CPU utilization and response time
  - Average turnaround time and maximum waiting time
  - I/O device utilization and CPU utilization

minimize context switching → increase CPU utilization

- Discuss how the following pairs of scheduling criteria conflict in certain settings.
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minimize context switching → increase CPU utilization

conflict → tasks would need to wait for a long time

increase response time
Q. 1

• Discuss how the following pairs of scheduling criteria conflict in certain settings.

  • Average turnaround time and maximum waiting time

SJF \rightarrow lower average turnaround time

• I/O device utilization and CPU utilization
Q. 1

• Discuss how the following pairs of scheduling criteria conflict in certain settings.

  - I/O device utilization and CPU utilization
    - maximize CPU utilization ➔ run long running CPU-bound tasks WITHOUT context switching
    - maximize I/O device utilization ➔ schedule I/O-bound tasks as soon as they’re ready NEED context switching

Q. 2

• Why is it important for the scheduler to distinguish I/O-bound programs from CPU-bound programs?

  - I/O-bound programs
    – Little computation
    – Many I/O operations
    – Do not use up their CPU quantum
  
  - CPU-bound programs
    – Much computation
    – Few I/O operations
    – Use up their CPU quantum

To use resources better
Give higher priority to I/O-bound programs
Q. 3

(a) Draw four Gantt charts illustrating the execution of these processes using
- FCFS
- SJF
- a nonpreemptive priority
  (a smaller priority number implies a higher priority)
- RR (quantum = 1)

5 processes arrived in the order P1, P2, P3, P4, P5, all at time 0.

<table>
<thead>
<tr>
<th>Process</th>
<th>Burst Time</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>P2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>P3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>P4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>P5</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

(b) What is the turnaround time of each process for each of the scheduling algorithms in part (a)?

(c) What is the waiting time of each process for each of the scheduling algorithms in part (a)?
Q. 3

(d) Which of the schedules in part (a) results in the minimal average waiting time (over all processes)?

SJF

Q. 4

• Consider a system running
  – 1 CPU-bound task
  – 10 I/O-bound tasks
    • each issue an I/O operation once for every 1 ms of CPU computing
    • each I/O operation takes 10 ms to complete
  – context switching overhead = 0.1ms
  – all processes are long-running tasks

• What is the CPU utilization for a round-robin scheduler when:
  
  (a) The time quantum is 1 ms

<table>
<thead>
<tr>
<th>Time quantum</th>
<th>Switching</th>
<th>CPU utilization:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ms</td>
<td>0.1 ms</td>
<td>1/1.1 = 91%</td>
</tr>
</tbody>
</table>
Q. 4

- Consider a system running
  - 1 CPU-bound task
  - 10 I/O-bound tasks
    - each issue an I/O operation once for every 1 ms of CPU computing
    - each I/O operation takes 10 ms to complete
  - context switching overhead = 0.1 ms
  - all processes are long-running tasks

- What is the CPU utilization for a round-robin scheduler when:

  (b) The time quantum is 10 ms

<table>
<thead>
<tr>
<th>I/O-bound tasks</th>
<th>CPU-bound tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>use 1 ms</td>
<td>Time quantum 10 ms</td>
</tr>
<tr>
<td>Switching 0.1 ms</td>
<td>Switching 0.1 ms</td>
</tr>
</tbody>
</table>

Time to cycle 10 I/O-bound tasks = 1.1 x 10

Time to cycle 1 CPU-bound tasks = 10.1

CPU utilization:

\[
\frac{20}{21.1} = 94\%
\]