**Question 1**

1. Operating systems can act as a resource allocator to allocate and deallocate the necessary amount of resources to keep processes functional and perform as intended. It may handle the allocation of resources so that each process obtains the exact required amount and prevent imbalance in resource allocation.

Operating systems can also act as a control program, especially as a program scheduler and interrupt, to schedule known processes and interrupt ongoing processes to give way to processes with higher priority. This allows operating systems to preempt urgent processes when required to meet expected deadlines.

1. Operational user: Users who performs validation and test features on the user interface. These users ensure that user interface features are functional and are fit for user applications.

End user: Users who actually use the user interface for their own tasks and benefits. These users usually provide feedback back to user interface developers if they discover a bug in the user interface.

Programmer: Users who write code to build and develop features of the user interface. These users improves the user interface after identifying the demands for it.

**Question 2**

1. Initializing: Process is being created

Waiting: Process is ready and waiting for execution

Running: Process is being executed by the processor

Terminated: Process is stopped from further processing and dropped.

Completed: Process is fully executed and complete

1. Throughput: The rate of receiving actual output through the scheduling algorithm

Waiting time: The time that processes waited after arriving until being executed by the processor

Completion time: The time used by the process to complete its full execution

Response time: The time difference between process completion and actual output of the process result.

Turnaround time: The time difference between arrival time and completion time

3.

4. FIFO: In terms of fairness, processes are treated fairly as the process that arrives earlier is first chosen for execution. However, the average waiting time for this algorithm is poor because if a process that has a long burst time arrives earlier, other processes need to wait until the process is completed before being executed. This will result the processes to undergo starvation, which is known as the Convoy effect.

(In terms of fairness, processes are treated unfairly because processes that arrives later needs to wait for earlier process to complete, even if they are priority jobs)

SJF: In terms of fairness, there is more bias in processes that have longer burst times as processes that have shorter burst times are prioritized first. The average waiting time for processes that have longer burst times are also high as they also experience starvation regardless of preemptive or non-preemptive algorithm.

RR: In terms of fairness, processes are treated fairly as processes are given an equal amount of time quantums for process execution. The average waiting time for processes is high as processes that have higher burst time than the set time quantum is divided into several segments to execute, and they must wait for other in-between process segments to finish executing before they can continue.

Priority: In terms of fairness, processes are treated unfairly because processes that have higher priority can replace ongoing processes that have lower priority. The average waiting time for processes that have higher priority is low because of their prioritization, but processes with lower priority are high because they are pre-empted by processes with higher priority.

5a)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| P3 |  | P1 | P5 | P2 | P4 |

0 3 4 9 13 17 19

|  |  |  |
| --- | --- | --- |
| Process | Turnaround Time | Waiting Time |
| P1 | 5 | 0 |
| P2 | 11 | 7 |
| P3 | 3 | 0 |
| P4 | 13 | 11 |
| P5 | 8 | 4 |

ATT: 5+11+3+13+8/5 = 8

AWT: 7+11+4/5 = 4.4

b)

Process P3 completes and is released from the processor, no other processes arrive during that time.

c)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P1 | P2 | P3 | P4 | P5 | P1 | P2 | P4 | P2 | P4 |

0 10 20 27 37 42 45 55 65 72 75

|  |  |  |
| --- | --- | --- |
| Process | Turnaround Time | Waiting Time |
| P1 | 45 | 32 |
| P2 | 72 | 45 |
| P3 | 27 | 20 |
| P4 | 75 | 52 |
| P5 | 42 | 37 |

ATT: 261/5 = 52.2

AWT: 186/5 = 37.2