Operating Systems Laboratory Assignment 5

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Part 1:

1. workload_mix1.sh (Completely CPU intensive)

```
#!/bin/bash
./arithoh.sh &
./arithoh.sh &
./arithoh.sh &
./arithoh.sh &
./arithoh.sh &
wait
```

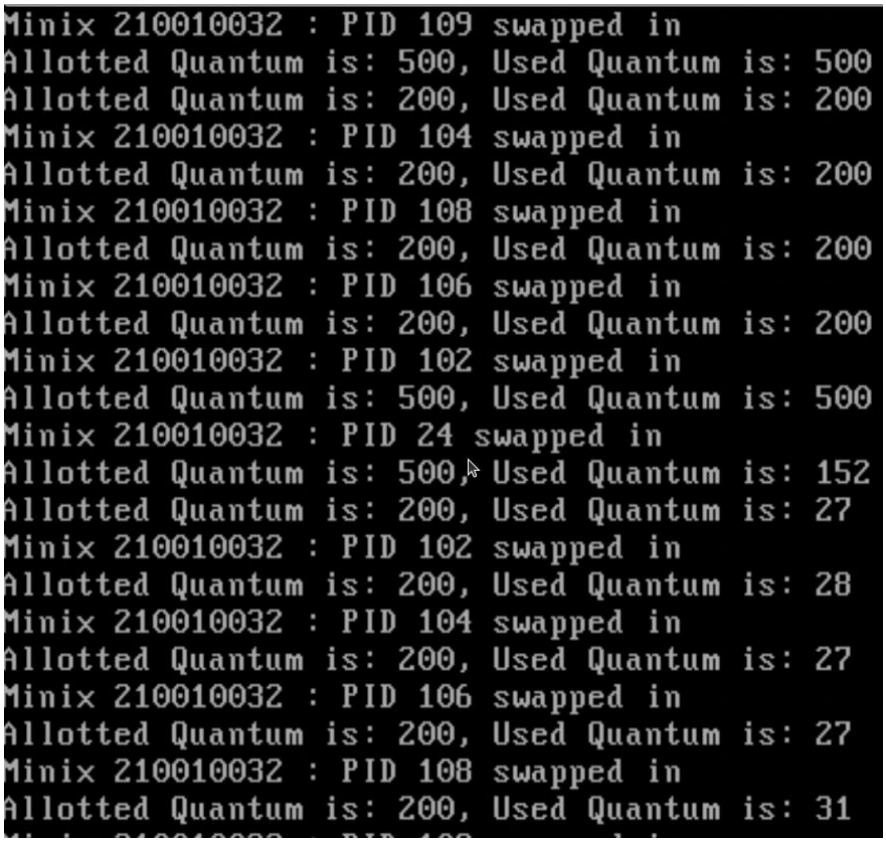
```
Minix 210010032 : PID 41 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 43 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 44 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 37 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 41 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 43 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 39 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 37 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 41 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 39 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 44 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 43 swapped in
```

The above screenshot shows the Processes being executed in a round-robin fashion, each arithoh process using the whole time quanta, 200 allotted, since it's a completely CPU bound process.

2. workload_mix2.sh (Completely I/O intensive)

```
#!/bin/bash
./fstime.sh &
./fstime.sh &
./fstime.sh &
./fstime.sh &
./fstime.sh &
wait
```

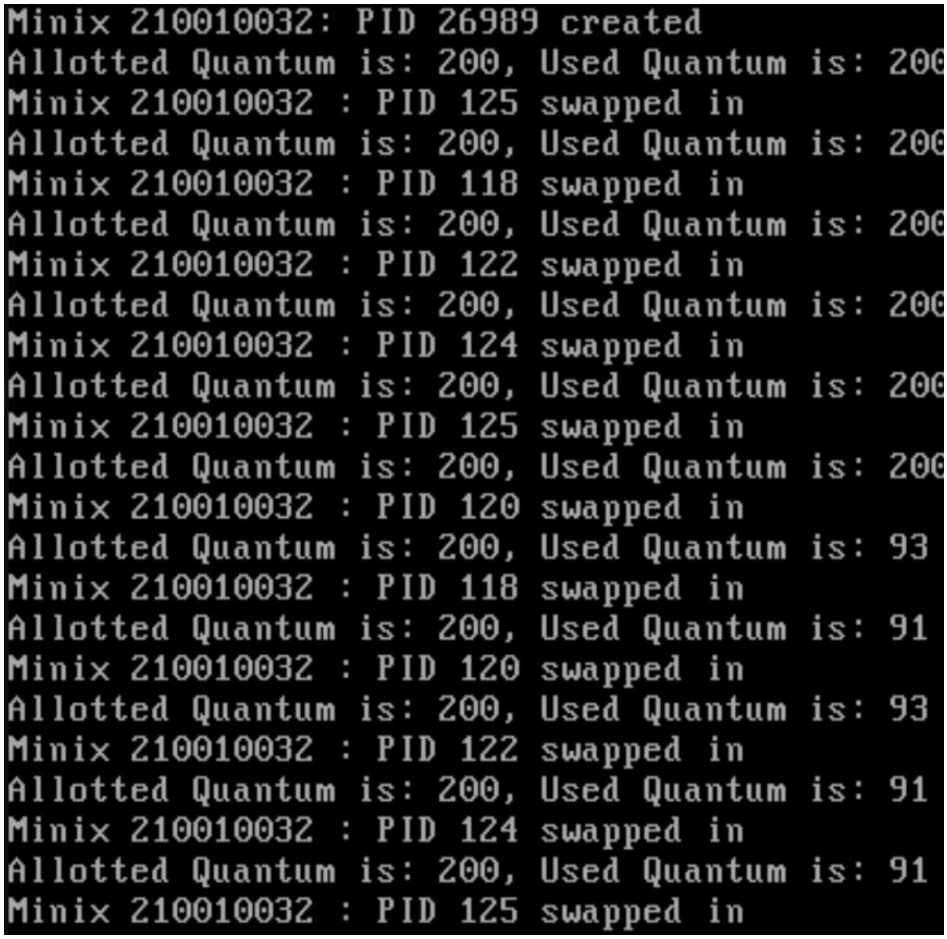
```
Allotted Quantum is: 500, Used Quantum is: 462
Allotted Quantum is: 500, Used Quantum is: 500
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 93 swapped in
Allotted Quantum is: 500, Used Quantum is: 500
Minix 210010032 : PID 24 swapped in
Allotted Quantum is: 500, Used Quantum is: 15
Allotted Quantum is: 200, Used Quantum is: 0
Minix 210010032 : PID 93 swapped in
```

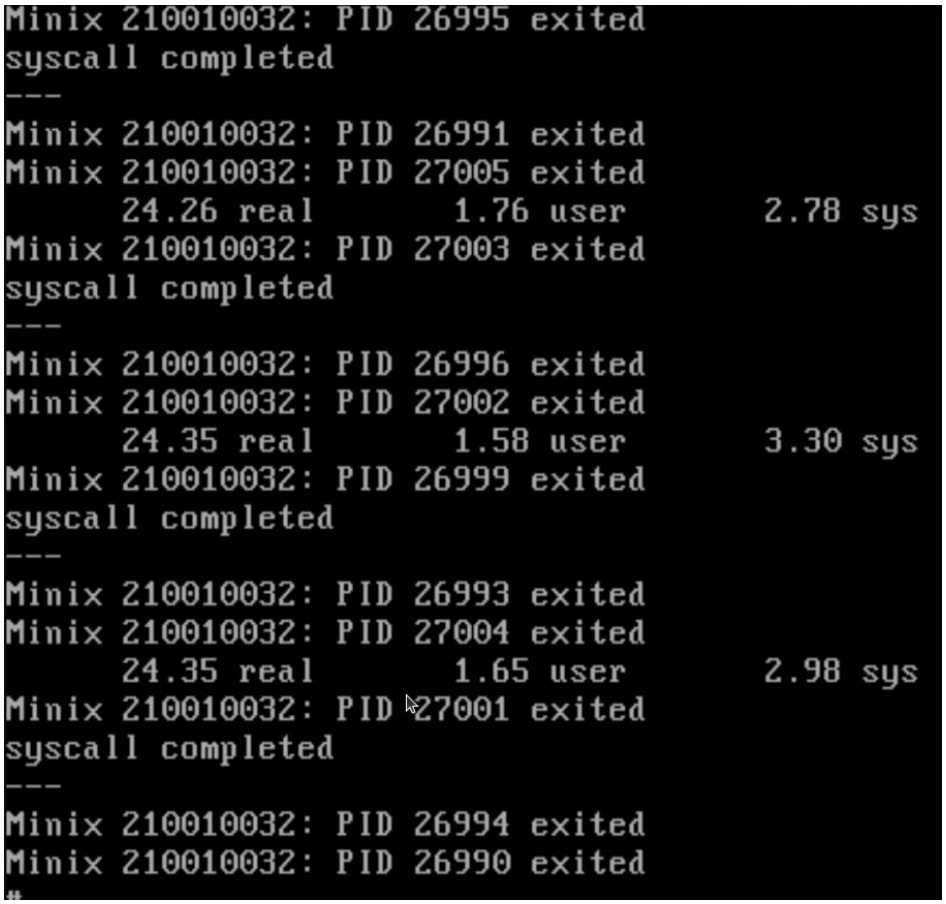


From above screenshots, the processes are running in a round robin fashion. Sometimes, fstime is allotted a time quanta of 500, since it's more I/O bound. It is also to be noted that there are observable pauses in between.

3. workload_mix3.sh (only system calls)

```
#!/bin/bash
./syscall.sh &
./syscall.sh &
./syscall.sh &
./syscall.sh &
./syscall.sh &
wait
```


Minix 210010032: PID 26989 created
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 125 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 118 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 122 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 124 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 125 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 120 swapped in
Allotted Quantum is: 200, Used Quantum is: 93
Minix 210010032 : PID 118 swapped in
Allotted Quantum is: 200, Used Quantum is: 91
Minix 210010032 : PID 120 swapped in
Allotted Quantum is: 200, Used Quantum is: 93
Minix 210010032 : PID 122 swapped in
Allotted Quantum is: 200, Used Quantum is: 91
Minix 210010032 : PID 124 swapped in
Allotted Quantum is: 200, Used Quantum is: 91
Minix 210010032 : PID 125 swapped in


Minix 210010032: PID 26995 exited
syscall completed

Minix 210010032: PID 26991 exited
Minix 210010032: PID 27005 exited
24.26 real 1.76 user 2.78 sys
Minix 210010032: PID 27003 exited
syscall completed

Minix 210010032: PID 26996 exited
Minix 210010032: PID 27002 exited
24.35 real 1.58 user 3.30 sys
Minix 210010032: PID 26999 exited
syscall completed

Minix 210010032: PID 26993 exited
Minix 210010032: PID 27004 exited
24.35 real 1.65 user 2.98 sys
Minix 210010032: PID 27001 exited
syscall completed

Minix 210010032: PID 26994 exited
Minix 210010032: PID 26990 exited

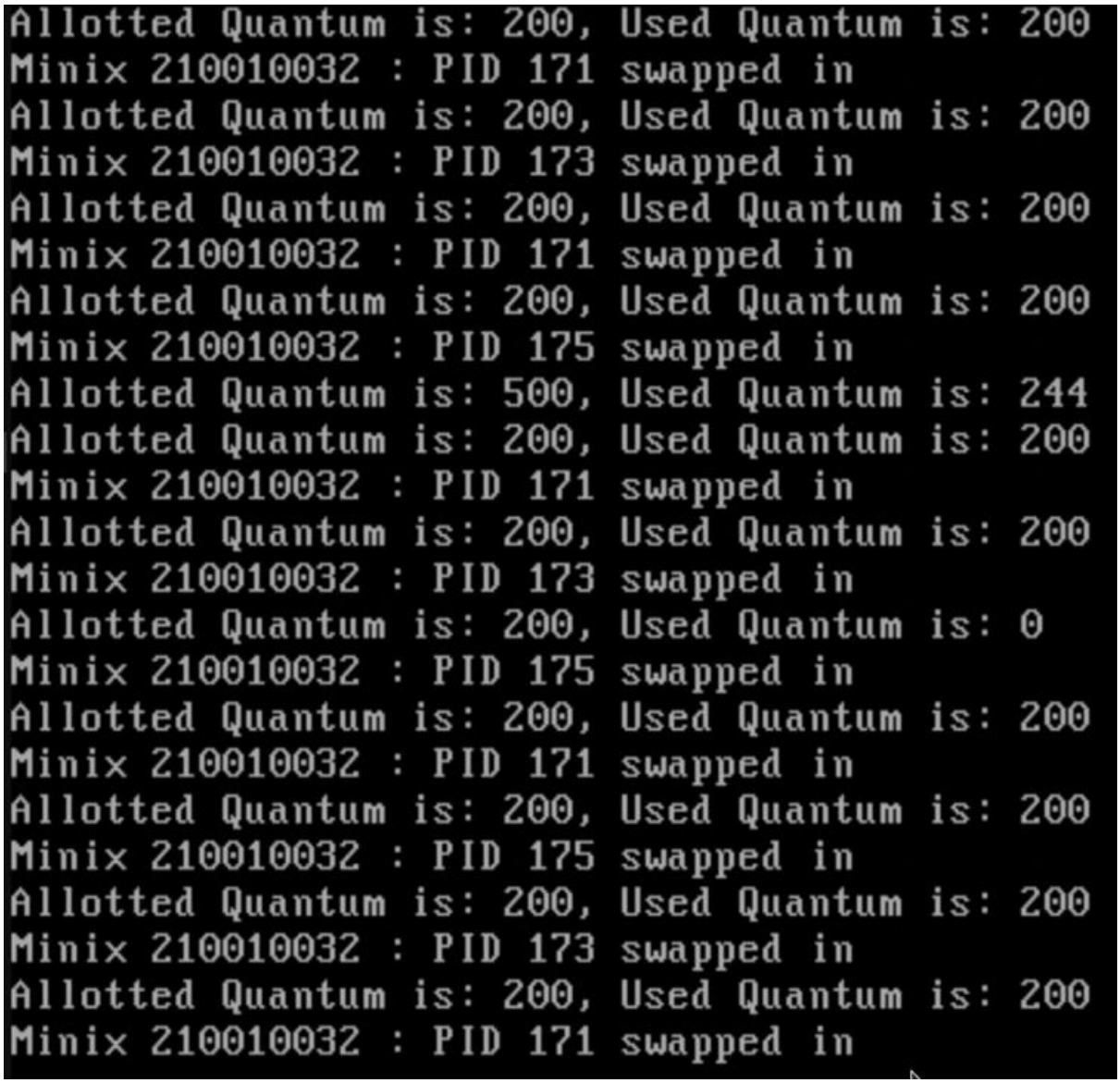
This workload mix has lot of system calls involved. Hence many times, it doesn't use the complete time quanta allotted to it as observed in above screenshots, which indicates that it is less CPU intensive than arithoh.

4. workload_mix4.sh (mix of arithoh, fstime and syscall)

```
#!/bin/bash
./arithoh.sh &
./arithoh.sh &
./arithoh.sh &
./fstime.sh &
./syscall.sh &
wait
```

```
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 177 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 175 swapped in
Minix 210010032: PID 27037 created
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 178 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 178 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 171 swapped in
Allotted Quantum is: 200, Used Quantum is: 0
Minix 210010032 : PID 171 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 173 swapped in
Allotted Quantum is: 200, Used Quantum is: 84
Minix 210010032 : PID 175 swapped in
Allotted Quantum is: 200, Used Quantum is: 0
Minix 210010032 : PID 178 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 173 swapped in
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032 : PID 175 swapped in
```

After fstime and syscall is executed:



We observe that syscall is completed first, followed by fstime and then the three arithoh processes execute. Sometimes, fstime gets time quanta of 500.

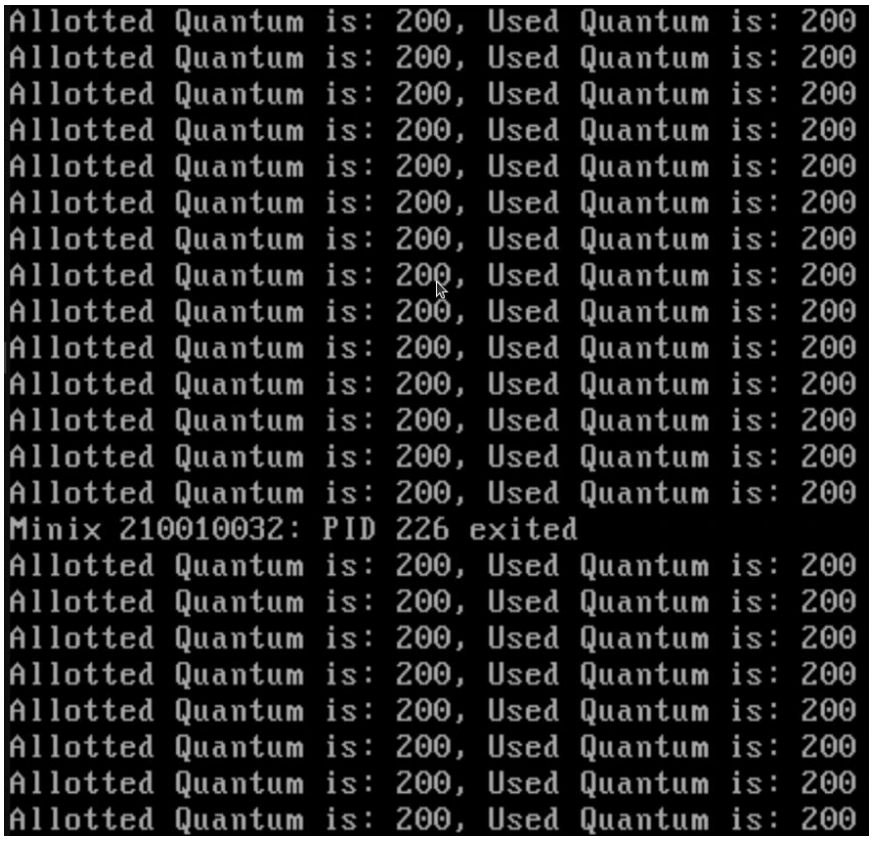
Part 2:

To make a pseudo FIFO scheduler, the following changes were made:

In minix/servers/sched/schedule.c, function do_noquantum() had a line rmp->priority += 1; which was changed to rmp->priority -= 1. This makes the scheduler to decrease the priority of the new incoming processes to pre emptively get time slices.

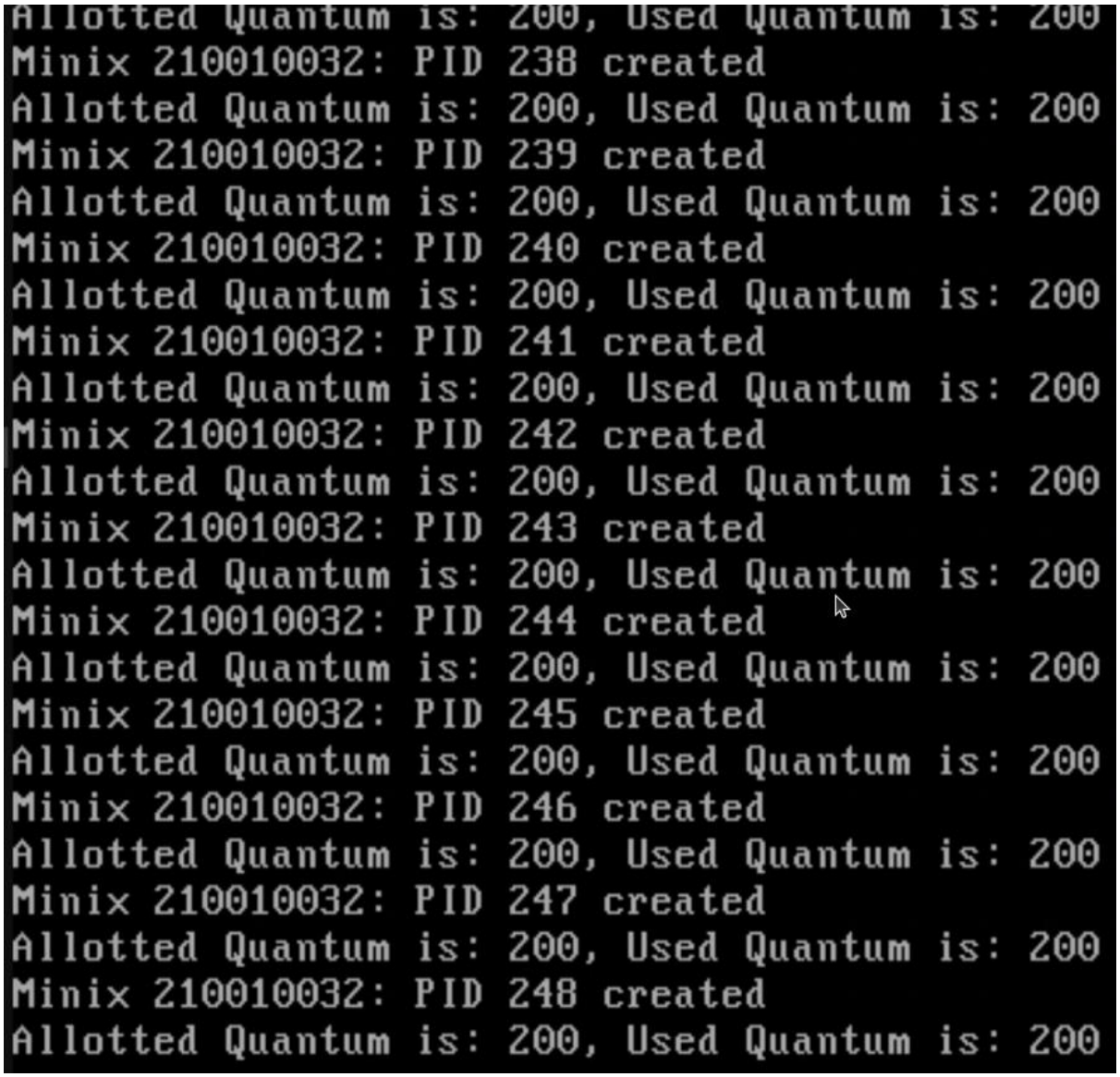
Also the function balance_queues() in the same file was changed by commenting out the rmp->priority -=1; line to not increase the priority of processes, to prevent overflow of the priority queue.

1. workload1-mix.sh



Since all arithoh are CPU intensive, the processes are executed sequentially, hence the processes are not swapped in until the process in ready queue is completed.

2. workload_mix2.sh



Here, the scheduling resembles round robin, since fstime is mostly I/O bound. Because, When a fstime process is waiting for I/O, another fstime process begins execution. Following FIFO will be inefficient in this case since CPU will be idle if the second process waits till completion of first process.

3. workload_mix3.sh

```
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 500, Used Quantum is: 500
Minix 210010032: PID 370 exited
       7.98 real         1.60 user         3.08 sys
Minix 210010032: PID 365 exited
syscall completed
---
Minix 210010032: PID 360 exited
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
```

```
syscall completed
---
Minix 210010032: PID 358 exited
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032: PID 372 exited
      16.06 real         1.70 user         3.08 sys
Minix 210010032: PID 367 exited
syscall completed
---
Minix 210010032: PID 362 exited
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032: PID 371 exited
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
```

We observe that since syscall is CPU intensive (but not as much as aritho), hence it follows FIFO and not the round robin we observe when fstime was executed multiple times.

4. workload4.sh

execution of arithoh:

```
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
```

After arithoh is completed:

```
Minix 210010032: PID 408 exited
       5.31 user       10.65 real        0.00 sys
Minix 210010032: PID 414 exited
arithoh completed
---
       5.33 userMinix 210010032: PID 409 exited
       0.00 sys
Minix 210010032: PID 416 exited
arithoh completed
---
Minix 210010032: PID 410 exited
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 200, Used Quantum is: 200
Minix 210010032: PID 422 exited
       4.81 real        1.63 user        3.18 sys
Minix 210010032: PID 420 exited
syscall completed
```

After syscall is completed:

```
suscall completed
Files
---
Minix 210010032: PID 413 exited
Write done: 1008000 in 0.9333, score 270000
COUNT¦270000¦0¦KBps
TIME¦0.9
Allotted Quantum is: 500, Used Quantum is: 500
Read done: 1000004 in 0.8667, score 288462
COUNT¦288462¦0¦KBps
TIME¦0.9
Allotted Quantum is: 200, Used Quantum is: 200
Allotted Quantum is: 500, Used Quantum is: 500
Copy done: 1000004 in 1.8500, score 135135
COUNT¦135135¦0¦KBps
TIME¦1.8
Minix 210010032: PID 421 exited
      22.80 real        0.35 user        3.30 sys
Minix 210010032: PID 418 exited
fstime completed
```

We observe that arithoh gets executed in a FIFO manner first, (all three of arithoh), then syscall is executed followed by fstime. It is observed that CPU first executed the more CPU bound processes first (arithoh), then less CPU bound (syscall) and then least CPU bound (fstime). This is because even if fstime enters queue first, it gets removed since it waits for I/O and more CPU bound process such as aritho gets inside queue and stays until it completes.