SET B

CPTS 360: Systems Programming — Fall 2023
Exam 2
Time Limit: 45 Minutes

This exam has 13 questions worth a total of 100 points.
This document contains a total of 16 pages.

The problems are of varying difficulty. The point value of each problem is indicated on the right.

Last Name: _____

First Name: _____

Instructions:

- Make sure that your exam is not missing any sheets, then clearly write your full name on the front page.
- This exam is closed-book, closed-note (except for 1-page double-sided handwritten note sheets).
- You may not use any electronic devices.
- You can use basic/scientific calculators.
- Write your answers in the space provided below the problem.
- If you make a mess, clearly indicate your final answer.
- For MCQ questions, clearly mark/circle the correct answer.

Do not start the exam until instructed.

Good Luck!

Question	Points	Score
1	10	
2	2	
3	2	
4	2	
5	10	
6	2	
7	6	
8	2	
9	6	
10	6	
11	8	
12	26	
13	18	
Total:	100	

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1. The Multi-level Feedback Queue (MLFQ) is a fancy scheduler that does lots of things.
   Which of the following things could you possibly say (correctly!) about the MLFQ approach?

   To answer: Mark A for Possible (True), B for Not Possible (False).

   (a) MLFQ learns things about running jobs **2 Points**

   A. Possible

   B. Not Possible

   Solution: By moving jobs down queues, it learns that they are long running (for example).

   (b) MLFQ starves long running jobs **2 Points**

   A. Possible

   B. Not Possible

   Solution: By bumping priority on occasion, MLFQ avoids starvation.

   (c) MLFQ uses different length time slices for jobs **2 Points**

   A. Possible

   B. Not Possible

   Solution: True, sometimes, across different queues.

   (d) MLFQ uses round robin **2 Points**

   A. Possible

   B. Not Possible

   Solution: True, within a given level.

   (e) MLFQ forgets what it has learned about running jobs sometimes **2 Points**

   A. Possible

   B. Not Possible

   Solution: True, with priority bump to top priority, all jobs look the same now, and all is forgotten about them.

2. Consider a Shortest Time-to-Completion First (STCF) scheduler which is similar to Shortest Job First (SJF), but supports preempting processes. **2 Points**

   Consider a job Aarrives at time T=0 and job length of 500 ms. Job B arrives at time T=100 ms with a length of 100 ms. What does the schedule for our CPU look like?

   A. A runs for 500 ms, then B runs for 100 ms

   B. B runs for 100 ms, then A runs for 500 ms

   C. A runs for 100 ms, then B runs for 100 ms, and then A runs again for 400 ms

   D. A runs for 100 ms, then A and B run in round-robin for 200 ms, and then A runs for another 300 ms

   E. A runs for 100 ms, then B runs for 100 ms, then A runs for 100 ms, then B runs for 100 ms, then A runs for 300 ms

   F. None of the above

3. In what regard is Multi-Level Feedback Queue (MLFQ) better compared to other schedulers such as Shortest Job First (SJF) or Shortest Time-to-Completion First (STCF)? **2 Points**

   A. Average Response Time
   B. Average Turnaround Time
   C. Fewer I/Os issued by processes
   D. CPU Utilization
   E. None of the above

4. Which of the following is not a benefit of virtual memory? **2 Points**

   A. It allows the virtual address space to be larger than the physical address space
   B. No process can accidentally access the memory of another process
   C. The TLB is more effective since without it dereferencing a virtual address now requires two or more memory accesses
   D. Different processes can have overlapping virtual address spaces without conflict
   E. None of the above

5. Assume the following schedule for a set of three jobs, A, B, and C:

```
A runs first (for 10 time units) but is not yet done
B runs next (for 10 time units) but is not yet done
C runs next (for 10 time units) and runs to completion
A runs to completion (for 10 time units)
B runs to completion (for 5 time units)
```

   Which scheduling disciplines could allow this schedule to occur?

   To answer: Mark A for Possible, B for Not Possible.

   (a) First in, First Out **2 Points**

   A. Possible
   B. Not Possible

   Solution: FIFO would run to completion, the schedule above does not.

   (b) Round Robin **2 Points**

   A. Possible
   B. Not Possible

   Solution: Switch jobs in RR order every 10 time units.

   (c) Shortest Time to Completion First **2 Points**

   A. Possible
   B. Not Possible

   Solution: Not possible because A is run to completion before B, which is shorter.

   (d) Multi-level Feedback Queue **2 Points**

A. Possible

B. Not Possible

Solution: Can act like RR, so is possible. Could have stayed on same queue, or switch queues.

(e) Lottery Scheduling **2 Points**

A. Possible

B. Not Possible

Solution: With lottery (random), anything is possible.

6. For a system with **2 Points**

$N = 2^n$ number of addresses in virtual address space,

$M = 2^m$ number of addresses in physical address space, and

$P = 2^p$ page size,

which bits in the physical address represent physical page number (PPN)?

A. 0 to p

B. 0 to p-1

C. p+1 to n

D. p+1 to m

E. p to n-1

F. p to m-1

G. None of the above.

7. Consider a new OS (named xOS) uses a multi-level feedback queue (MLFQ) to schedule processes.

The queue has four levels and uses a quantum (time slice) length of 10 ms. Processes start at high priority (4) and then change priority as MLFQ dictates.

You can assume that context switches do not take any time or resources. You also do not have to take more advanced MLFQ modifications into account, such as priority boosting or variable time-slice length, unless otherwise mentioned.

(a) Consider we run a process P1 as follows: **2 Points**

- P1 starts at high priority (4);
- P1 uses the CPU for 15 ms;
- Then waits for I/O for 5 ms, and
- Then keeps using the CPU for another 100 ms before it finishes.

What priority level does P1 have after the first three time slices (30 ms total)? Assume there are no other processes in the system.

A. 1

B. 2

C. 3

D. 4

E. None of the above

(b) Now consider that 5 ms after P1 was started, we start another process P2. **2 Points**

P2 alternates between first using the CPU for 5 ms and then waiting on I/O for another 5 ms. P2 runs for 100 ms total. What does the CPU schedule look like for the first five time slices?

A. P1, P2, P2, P2, P2
B. P1, P2, P2, P1, P2
C. P1, P1, P1, P2, P2
D. P2, P2, P2, P2, P2
E. None of the above

(c) Recall that xOS developers decided not to add boosting to their MLFQ scheduler. **2 Points**

What problems could this cause?

A. Interactive jobs might not be scheduled at al
B. CPU-heavy (batch) jobs might get starved
C. Batch jobs will stay at the highest priority level
D. There can only be one job at the highest priority level
E. None of the above

8. Which one is true for Stride Scheduling? **2 Points**

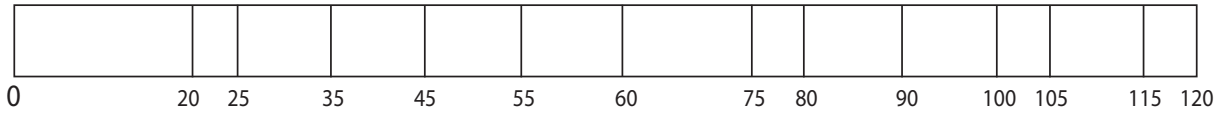
A. Easier to incorporate new processes.
B. Does not require global per-process state.
C. Non-deterministic by nature.
D. If a new job enters with a pass value 0, it will monopolize the CPU.
E. None of the above.

13. The following processes are being scheduled using a preemptive, round-robin scheduling algorithm.

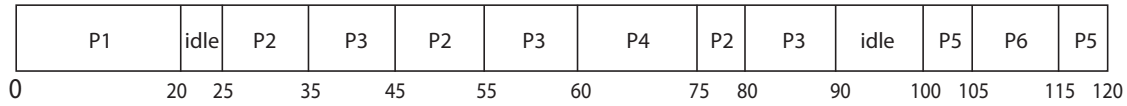
Process	Priority	Burst	Arrival
P1	40	20	0
P2	30	25	25
P3	30	25	30
P4	35	15	60
P5	5	10	100
P6	10	10	105

Each process is assigned a numerical priority, with a higher number indicating a higher relative priority. In addition to the processes listed above, the system also has an idle task (which consumes no CPU resources and is identified as PIDL). This task has priority 0 and is scheduled whenever the system has no other available processes to run. The length of a time quantum is 10 units. If a process is preempted by a higher-priority process, the preempted process is placed at the end of the queue.

(a) Complete the scheduling order of the processes using the following Gantt chart. **12 Points**
For example, time 0 to 20, process P1 will be scheduled.



Solution:



(b) What is the turnaround time for each process? **6 Points**

- P1:
- P2:
- P3:
- P4:
- P5:
- P6:

Solution:

P1: 20-0=20

P2: 80-25=55

P3: 90-30=60

P4: 75-60=15

P5: 120-100=20

P6: 115-105=10

Scratch paper: intentionally left blank for your rough notes. Contents of this page will not be graded.