6. Memory Interference [50 points]

During the lectures, we introduced a variety of ways to tackle memory interference. In this problem, we will look at the Blacklisting Memory Scheduler (BLISS) to reduce unfairness. There are two key aspects of BLISS that you need to know.

- When the memory controller services η consecutive requests from a particular application, this application is blacklisted. We name this non-negative integer η the **Blacklisting Threshold**.
- The blacklist is cleared periodically every **10000** cycles starting at t=0.

To reduce unfairness, memory requests in BLISS are prioritized in the following order:

- Non-blacklisted applications' requests
- Row-buffer hit requests
- Older requests

The memory system for this problem consists of 2 channels with 2 banks each. Tables 1 and 2 show the memory request stream in the same bank for both applications at varying times. The memory requests are labeled with numbers that represent the row position of the data within the accessed bank. Assume the following for all questions:

- A row buffer hit takes **50 cycles**.
- A row buffer miss/conflict takes **200 cycles**.
- All the row buffers are closed at time t=0.

Application A (Channel 0, Bank 0)							
Application B (Channel 0, Bank 0)	Row 1	Row 1	Row 1	Row 1	Row 1	Row 1	Row 1

Table 1: Memory requests of the two applications at t=0

Application A (Channel 0, Bank 0)	Row 3	Row 7	Row 2	Row 0	Row 5		
Application B (Channel 0, Bank 0)	Row 1	Row 1	Row 1	Row 1	Row 1	Row 1	Row 1

Table 2: Memory requests of the two applications at t=10

(a) Compute the slowdown of each application using the FR-FCFS scheduling policy after both threads ran to completion. We define $slowdown = \frac{mem\_latency\_with\_others}{mem\_latency\_alone}$. Show your work.

Slowdown of A: $\frac{(200+6*50)+5*200}{5*200} = \frac{1500}{1000} = 1.50$

Slowdown of B: $\frac{200+6*50}{200+6*50} = \frac{500}{500} = 1.00$

(b) For what value(s) of η (the Blacklisting Threshold) will the slowdowns for both applications be equivalent to those obtained with FR-FCFS?

For $\eta \geq 7$ or $\eta = 0$.
We want both A and B to complete without blacklisting or to complete both blacklisted, thus $\eta \geq 7$ and $\eta = 0$ respectively.

(c) For what value(s) of η (the Blacklisting Threshold) will the slowdown for A be <1.4?

Impossible. Slowdown for A will always be $\geq$1.4.
If you trace the schedule carefully, you will observe that A will be the fastest when η=5, where slowdown of A=1.4. η=5 is the smallest η where A does not get blacklisted.

(d) For what value(s) of η (the Blacklisting Threshold) will B experience maximum slowdown it can experience with the Blacklisting Scheduler?

η=5 or η=6
We observe that as long as B gets blacklisted at least once, B will incur an additional miss and hence an extra of 200 cycles. Thus, we want 2 conditions to be satisfied: B to miss at least once AND an η such that B completes last. These conditions are satisfied only when η=5 or η=6. $MaximumSlowdownofB = \frac{1650}{500} = 3.3$

(e) What is a simple mechanism (that we discussed in lectures) that will make the slowdowns of both A and B 1.00?

Memory Channel Partitioning (MCP)