**Problem 6: Remember This (BONUS)** (20 pts)

A researcher has developed a new type of nonvolatile memory, BossMem. He is considering BossMem as a replacement for DRAM. BossMem is 10x faster (all memory timings are 10x faster) than DRAM, but since BossMem is so fast, it has to frequently power-off to cool down. Overheating is *only a function of time*, not a function of activity—an idle stick of BossMem has to power-off just as frequently as an active stick. When powered-off, BossMem retains its data, but can't service requests. Both DRAM and BossMem are banked and otherwise architecturally similar. To the researcher's dismay, he finds that a system with 1GB of DRAM performs considerably better than the same system with 1GB of BossMem.

**A) [4 pts]** What can the researcher change or improve in the core (he can't change BossMem or anything beyond the memory controller) that will make his BossMem perform more favorably compared to DRAM, realizing that he will have to be fair and evaluate DRAM with his enhanced core as well? (15 words or less)

Prefetcher degree or other speculation techniques so that misses can be serviced before memory powered off

**B) [4 pts]** A colleague proposes he build a hybrid memory system, with both DRAM and BossMem. He decides to place data that exhibits low row buffer locality in DRAM and data that exhibits high row buffer locality in BossMem. Assume 50% of requests are row buffer hits. Is this a good or bad idea?

CIRCLE ONE: **GOOD** **BAD**

Show your work.

No, it may be better idea to place data with high row buffer locality in DRAM and low row buffer locality data in BossMem since row buffer misses are less costly

**C) [4 pts]** Now a colleague suggests trying to improve the last-level cache replacement policy in the system with the hybrid memory system. Like before, he wants to improve the performance of this system relative to one that uses just DRAM and he will have to be fair in his evaluation. Can he design a cache replacement policy that makes the hybrid memory system look more favorable?

CIRCLE ONE: **YES** **NO**

In 15 words or less, justify NO or describe a cache replacement policy that would improve the performance of the hybrid memory system more than it would DRAM.

Yes, this is possible. Cost-based replacement where cost to replace is dependent on data allocation between DRAM and BossMem



Continued . . .

**D) [4 pts]** In class we talked about another nonvolatile memory technology, phase-change memory (PCM). Which technology, PCM, BossMem, or DRAM requires the greatest attention to security?

CIRCLE ONE: **PCM** **BossMEM** **DRAM**

What is the vulnerability (less than 10 words)?

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|---|
| PCM is nonvolatile and has potential endurance attacks. |

**E) [4 pts]** Which is likely of least concern to a security researcher?

CIRCLE ONE: **PCM** **BossMEM** **DRAM**

Why (less than 10 words)?

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|---|
| DRAM is likely least vulnerable, as BossMem also has nonvolatility concerns. |