CmpSci 635
Modern Computer Architecture
Sample Midterm Exam Name: _____

This exam is open book, papers, and notes. Use of electronic communication devices is not allowed without permission. A calculator may be needed for some of the problems.

The questions are related to the material covered in the book or papers for each topical section of the course. In each case there are multiple questions. Choose just one of the set to answer. Indicate the one you choose by **circling the letter**. All of them count for the same amount of credit. No extra credit will be given for answering additional questions in a set.

1. **Methodology** Diwan09, Citron03, Desikan01, John06, Hill02. Yang15

a. Diwan makes a case that experimental bias is subtle yet significant in architecture studies. What are some approaches that can be used to reduce bias?
b. Desikan claims to test accuracy and stability for their simulator. What are the pros and cons of their approach to achieving this?
c. What does Hill's characterization of commercial workloads say about the generality of other benchmarks like SPEC and SPLASH?
d. John argues that some of the SPEC benchmarks are redundant. What factors might still cause someone to choose one member within each cluster over another member for their benchmark subset?
e How did Yang address the issue of observer effect, and under what conditions do their efforts fall short?

2. **Experience** Agarwal04, Gebhart09

a. Agarwal defines a new metric, called versatility. Why do you think they invented this, and why wouldn't other researchers use it?

b. The Gebhart paper they invest significant effort in showing how better optimizations and idealized implementations of the architecture would deliver better performance. Why would they do this, and then still conclude that TRIPS is not viable as as architectural approach?

3. **Wearout** Torellas08, Lee09, Shin08

a. Torellas proposes slow-age and high-speed, based on either Adaptive Supply Voltage or Adaptive Body Bias. Why does he prefer ASV- over Reverse Body Bias for slow-age and then switch to Forward Body Bias instead of ASV+ for high-speed?
b. Shin's proactive wearout recovery requires that cache banks be saved during the recovery phase. Contrast the invalidation drain mechanism with the migration mechanism in terms of advantages and disadvantages of each.
c. Lee explores the feasibility of using Phase Change Memory to replace DRAM. He cites the improvement in endurance to 5.6 years on average, by using partial writes, as evidence that PCM can replace DRAM. Is there are problem with this argument? Justify your answer.

4. **Memory** Sridharan15, Wulf95, Moss93, Nakaike15

a. Considering Figure 7 in Sridharan, what is the biggest factor affecting SRAM fault rate?

b. The Wulf paper describes several ideas for avoiding the memory wall. Did any of them contribute to the delay we have seen in hitting it?

c. What are some assumptions in the Moss paper that have turned out to be unrealistic?

d. What are some limitations of the methodology in the Nakaike paper?

5. **Cache** Sim13, Korgaonkar18, Wang03, Jain18

a. According to the Sim paper, reading from the different chips in a memory stack simultaneously is a bad idea. Why?
b. In Korgaonkar, explain how bypassing writes to the LLC and instead going directly to the DRAM avoids a bottleneck.
d. Which of the compiler hints in the Wang paper had the greatest effect? Why were the others less effective?
e. In Jain, what factors are taken into account in making a prediction with Hawkeye and OPTGen?

6. **Multithreading and Predication** Tullsen95, Mahlke95

a. How does Tullsen's simultaneous multithreading differ from fine grained multithreading?

b. What are the advantages a disadvantages of full versus partial predication identified in Mahlke's paper?

7. **Pipelining** Sohi90, Sleiman16

a. How does Sohi's Register Update Unit differ from Cray's scoreboarding approach?
b, Sleiman shows that a large fraction of instructions can be issued in sequence with a 4-thread system. Why do you think they don't compare with an in-order baseline in addition to the OoO baseline?