Midterm Exam Notes

MPCS 52060 – Parallel Programming

October 24, 2021

Quarter Exam Structure

The exam will consist of the following types of questions:

- 5 Short Answer Questions (which may have multiple parts)
- 3 Programming Questions (i.e., given a problem, provide the Go code that solves this problem)

You will be given 90 minutes to complete the exam. The exam will be open-everything (books, notes, internet, etc.). However, you must uphold academic honestly where you cannot communicate with anyone (i.e., classmates, peers, friends, family, etc.) during the exam.

Quarter Exam Topics

- What is, and Why Parallel Computing?
- Parallel computer systems
  - Flynn's taxonomy (SIMD, SISD, MIMD)
  - SIMD systems
  - SISD systems
  - MIMD systems
- Parallel architecture
  - Internal parallelism
  - Simultaneous multithreading
  - Interconnect architecture for SMP systems
  - Distinction between processors, threads, and memory
  - Caches and its properties
  - MESI protocol
- Shared memory systems
  - What is a shared memory system
  - Programming on shared memory systems
  - You don't need to study other ones
- Low-level synchronization mechanism
  - Atomic operations
  - Semaphores

  - Monitors
  - Barriers
  - Condition variables
- Theoretical principles of parallel computing
  - Mutual exclusion property
  - Deadlock-freedom property
  - Starvation-freedom property
  - Fairness principle
- Theoretical practical lock implementations
  - LockOne, LockTwo, Peterson Lock
  - Lamport Bakery
  - TAS Lock
  - TTAS Lock
  - Exponential Backoff Lock
  - Anderson Lock (ALock)
- Parallel performance
  - Amdahl's law
- Concurrent linked lists implementations
  - Coarse-grained
  - Fine-grained
  - Optimistic
  - Lazy
  - Lock-free

The above topics are a quick outline of the topics we discussed. All information about these topics are covered in the lecture slides, which you can be accessed in the upstream repository. The exam will only cover material presented in Week 1 - Week 4.

Additional Notes

1. The exam will be posted on **Thursday October 28th at 12:00pm CST** and you will have until **Monday November 1st at 12:00pm CST (Week 6)** to complete it. **This is noon and not midnight!** The exam will be 90 minutes.
2. Once I post the exam, I will not be answering any questions related to the material covered in Week 1 - Week 4 until the exam deadline has passed. The main reason for this is to ensure those students who take the exam early are not at a disadvantage to students who take the exam later in the week, where questions may have been asked. Once you submit you exam, you cannot go back. It wouldn't be fair to those who take the exam early to not be able to correct their answers based on a question asked later.
3. I will not clarify any questions on the exam. However, you can make assumptions where in your response you can say, "Professor Samuels, I'm assuming x y z....". Now, whether your assumption is valid or not will be determined once I grade it. Again, this is not to be harsh but rather to give a fair testing environment for everyone.

4. We will be using Gradescope as our platform to administer the exam. You can login and take the "Sample Midterm Exam" starting on Sunday October 24th @ 7:00opm CST.

   The purpose of the sample exam is for you to get familiar with the Gradescope's exam platform and its interface. Thus, by the time you take the exam there should be no surprises about the format/structure of the questions and interacting with Gradescope. You can only "take" the sample exam once so make sure to look around and get comfortable with interface and structure of the exam before leaving it. **You do not have to actually take the exam and submit it. This is not for a grade.**

5. The questions on the sample quarter exam are not of the difficulty as the actual exam questions. The actual exam questions will require little more thought to them. Again, these are sample questions used to allow you to get familiar with the exam structure. Short answers questions will come first followed by the programming questions. Also, the exam will have more questions.

Let me know if you have any issues with using Gradescope. Please make sure you look at the sample exam before taking the actual exam.

How to Study for the Exam?

I think the best way to study for the exam is going through the lecture slides. You can reference the book for more in-depth information about a certain topic if you're still confused. If you're comfortable with the material presented in the lecture slides along with any companion slides than you should be a good shape for doing well on the exam. Here's some additional tips

- Make sure you understand the strengthens and weaknesses for the synchronization types and primitives I discussed in the lectures. Don't just know what they are but also think about cases where one would be better than the other one. For example,
  - Why don't we just use TAS lock? It solves the problem for mutual exclusion instead a fancier lock like the Anderson lock. You should be able to answer this question.
- I would probably make a cheat-sheet of the basic overview for the topics described above so you can reference it while taking the example to refresh your memory on different concepts.
- Make sure to review the lecture videos. For each video, I took the time to provide time segment so you can skip to the material you need more clarification on instead of watching the entire video over again.
- Make sure you review your go syntax and make sure you are comfortable with the constructs we talked about in the go sync package.