Date and Time: CSIS and EAS-CS PhD Preliminary Exams will be held in January on the last Thursday and Friday before the start of classes (Architecture and OS on Thursday Algorithms & Theory will be on Friday). The exam will start at 10:00 a.m. There will be a two hours time per subject area. For the location of the exam, please contact the CSE Office the week prior to the exam date.

Guidelines for CSIS PhD Preliminary Examination

Algorithms

The syllabus for Graduate Algorithms, CSC 5451 gives an overview of course material that will help you prepare for the preliminary exam:

http://cse.ucdenver.edu/~gethner/GradAlgorithms/GradAlgorithmsFall2017.html.

The lecture notes and homework assignments for CSC 5451 provide further insight into the topics. Please contact Professor Gethner (ellen.gethner@ucdenver.edu) for lecture notes and assignments if you did not take CSCI 5451 with her.

- **Design and Analysis Techniques**
  - Divide and Conquer
  - Greedy
  - Dynamic
- **Basic Algorithms**
  - Algorithms involving sequences and sets: order statistics, string manipulation, data compression
  - Graph Algorithms: network flows, planarity, graph coloring
  - Algebraic Algorithms: polynomial multiplication, Fast Fourier Transform
- **Advanced Topics**
  - Randomized algorithms
  - Cryptography: RSA, quantum cryptography
  - Computational Geometry

Helpful Textbooks

- Cormen, *et. al., Introduction to Algorithms, 3rd edition*
- Kleinberg and Tardos. *Algorithm Design*

- S.C Coutinho, *The Mathematics of Ciphers: Number Theory and RSA Cryptography*

Computer Architecture

1. The syllabus for Advanced Computer Architecture, CSC 5593 provides general information about the course that may help you prepare for the preliminary exam.

2. The lecture notes, projects and homework assignments for CSC 5593 provide further insight into the topics. Some literature references used in lecture notes and homework assignments are also helpful to expand your knowledge and apply them to various subjects.

3. Topics: Knowledge and familiarity with the following topics is expected:

Instruction Sets
Addressing Techniques
Fetch and Execute Cycle
Basic Pipelining, Pipeline hazards and handling
Pipelining and Performance
Memory Hierarchy
Caches
    Mapping Techniques (direct, set associative, fully associative)
    Cache Misses, Miss penalty, cache hit, Techniques for handling and reducing misses, allocation and Replacement strategies
Compiler optimization techniques for reducing cache misses
Virtual Memory
Instruction Level Parallelism (ILP)
Dynamic Execution
    Types of dependencies (flow, anti, and output dependence, control dependence)
    Hazards, Methods for handling them
    Out-of-order execution
    Dynamic Scheduling: Tomasula's Algorithm
    Register Renaming (with register files)
    Reorder Buffer (ROB)
    Advantages
Branch Prediction Methods
    1-bit Branch-Prediction Buffer
    2-bit Branch-Prediction Buffer
    Correlating Branch Prediction Buffer
    Tournament Branch Predictor
    Branch Target Buffer
Overall Familiarity with Definition of Modern Processor Technologies and their distinctions
    Superscalar
    Superpipeline
    Hyper Threading
    SMT
    SMP

CMP
Processor Core

4. Many textbooks are excellent source of information. The Advanced Architecture course draw from several textbooks and sources, the two recommended for class are:
Hennessey and Patterson, Computer Architecture: A Quantitative Approach, 5th Ed., 2011 ISBN: 978-0-12-383872-8. Note the 4th Ed. Is also fine.

Reference Book: J.P. Shen & M. Lipasti "Modern Processor Design: Fundamentals of Superscalar Processors", McGraw-Hill, 2005 ISBN: 0-07-057064-7

Operating Systems

The goal of test is to assess a student's understanding of the fundamental concepts in operating system area. Exam questions will be mixture of problem solving and short essay questions. Essay questions could include asking design choices, asking system/algorithm evaluations, or/and designing OS functions or systems.

The exam may cover the following topics:

1. Operating system structures and basic concepts including OS functions and goals
    a) What OS does?
    b) What are the main function of OS
    c) Types of OS
    d) Monotonic-Kernel OS vs. Micro-Kernel OS
2. Process and thread management and scheduling algorithms
    a) Concept of process and thread
    b) Process scheduling algorithms
    c) Context switching issues
    d) Inter-process communications
    e) Types of threads and usage of threads
3. Process synchronization, concurrency control and deadlocks
    a) Race-Condition and Critical Section
    b) Peterson's Solution
    c) Semaphore
    d) Synchronization
    e) Deadlock conditions
    f) Handling deadlock
    g) Banker's algorithm
    h) Recovery of deadlock
4. Main memory and virtual memory management
    a) Static allocation vs. dynamic allocation
    b) Internal & external fragmentation
    c) Memory allocation algorithms
    d) Paging and Segmentation
    e) Kernel memory allocation
    f) Demand paging
    g) Memory replacement algorithms

h) Belady's anomaly
i) Thrashing
j) Working set and resident set

5. File systems and Storage Management
    a) File structure
    b) File access methods
    c) File allocation strategies
    d) File sharing, protection, efficiency, performance and recovery
    e) Types of file systems including VFS
    f) Free space managements
    g) Disk access latency
    h) Disk scheduling
    i) RAID
    j) Disk attachment: DAS, NAS, and SAN
6. I/O Management
    a) Types of I/O implementations: polling, interrupt, and DMA
    b) Block and Character devices
    c) Kernel I/O subsystem
    d) Error handing and protection
    e) Performance
7. Protection & Security
    a) Protection
    b) Access matrix
    c) Access Control
    d) Capability
    e) Security
    f) Threats & attacks
8. Virtual Machine
    a) History and concept of virtual machine
    b) Types of virtual machines
    c) Virtualization and Operating System Components

Reference books: (One of the following books should be enough)

1. Silberschatz, Galvin, and Gagne, Operating System Concepts, 9th ed., John Wiley & Sons, Chapter 1 – 16
2. Tanenbaum, Modern Operating Systems, 3rd ed., Prentice-Hall. Chapters 1- 6, 9, and 13
3. Stallings, Operating Systems: Internals and Design Principles, 7th ed, Prentice-Hall, Chapters 1-12

Tips for preparing exam:

1. Thoroughly understand basic concepts each topics
2. Practice all problem questions at the end of each chapter

3. Stallings, Operating Systems: Internals and Design Principles, 6th ed, Prentice-Hall, Chapters 1-12

Tips for preparing exam:

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Theory

The reference book “Essentials of Theoretical Computer Science” by F. D. Lewis is recommend source for study. The textbook is on-line at
http://www.cs.uky.edu/~lewis/texts/theory/title.pdf .

You may contact Professor Altman with additional questions.