King Fahd University of Petroleum & Minerals
College of Computer Sciences and Engineering
Information and Computer Science Department

PhD Degree in Computer Science

Comprehensive Exam Preparation Guidelines

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CS Ph.D. Comprehensive Exam Preparation Guidelines

The following is a set of necessary remarks to assist while preparing the exam by examiners and for the exam by students:

1. The Ph.D. written comprehensive exam shall be offered twice a year; once in the Fall and another in the Spring semesters.
2. The exam will be held during the 8th week of the respective semester.
3. The exam duration in each area is 180 minutes.
4. The exam is closed book.
5. The exam is topic based; it is neither course based nor book based.
6. The exam tests for fundamental knowledge and academic maturity in the concerned area.
7. The exam contains three types of question:
    a. Questions that test basic foundations in the concerned area (a good undergraduate student should be able to answer these questions)
    b. Questions that test advanced concepts in the concerned area (a good graduate student should be able to answer these questions)
    c. One or more research-oriented questions to assess the student's approach in addressing research problems.
8. The student should score at least 70% in order to pass the exam. Scoring below 70% results in repeating the written exam during the next semester. Failing the written exam in the second time results in taking an Oral Exam during the same semester. Failing the Oral Exam results in dismissal.
9. The first attempt of the comprehensive exam must be in the 3rd semester.
10. A student who fails two or more areas is considered as FAIL and must retake the exam with all the three areas. A student who fails only one area can retake the exam with only that area in the next semester.
11. The second and last attempt of the comprehensive exam must be in 4th semester.
12. The exam topics are shown in the following pages.

Area A: "Algorithms and Artificial Intelligence"

Algorithms Topics:

1. Complexity Analysis: Asymptotic complexity, Big O/Ω/Θ, and small-o notations, analyzing iterative and recursive algorithms, the Master theorem.
2. NP-Completeness: Classes P, NP, NP-Complete, and co-NP, polynomial time reductions.
3. Lower bounds: The decision tree and algebraic decision tree methods, the linear time reduction method. (e.g. proving lower bounds for sorting, uniqueness, convex-hull, closest-pair, and the Euclidean minimum spanning tree problems).
4. Backtracking and branch-and-bound techniques. (e.g. Graph-coloring, 8-queens problem, Traveling salesman problem).
5. Approximation algorithms: difference bound, approximation ratio. (e.g. Bin packing, Euclidean traveling salesman, and Vertex cover problems)
6. Randomized algorithms: Monte Carlo and Las Vegas Algorithms, Randomized Quicksort, the Birthday problem.
7. Network flow: Ford-Fulkerson method, maximum capacity augmentation, and shortest path augmentation.
8. Matching: the network-flow method, and the Hungarian tree method.
9. Computational Geometry: Computing the maximal points, the convex-hull problem.

Artificial Intelligence Topics:

1. Classical Planning
2. Planning and Acting in the Real World
3. Quantifying Uncertainty
4. Probabilistic Reasoning
5. Probabilistic Reasoning over Time
6. Making Simple Decisions
7. Making Complex Decisions
8. Learning from Examples
9. Learning Probabilistic Models
10. Reinforcement Learning

Recommended References:

1. M. Alsuwaiyel, "Introduction to Algorithms: Design Techniques and Analysis", World Scientific Publishing Co., Inc. 1999.
2. T. Cormen, C. Leiserson, R. Rivest & C. Stein, "Introduction to Algorithms", 2nd Edition, The MIT Press, 2001.
3. S. Russell and P. Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition (International Edition), Pearson Education, 2009.

Area B: "Systems and Languages"

Operating Systems Topics:

1. Process Concept and Management
2. Multithreading Models
3. Concurrent execution and Bottleneck Analysis
4. Synchronization and Communication of Processes
5. Main and Virtual Memory Management
6. I/O Management, Mass-Storage
7. File System, Error Detection and Recovery
8. Multiprocessor and Real-Time Scheduling
9. Distributed Operating Systems
10. Distributed Deadlock Handling, Distributed Shared Memory, and Distributed File System
11. Performance Analysis and Evaluation of CPU and Disk Scheduling Algorithms
12. Developing Simulation Models for Computer Systems Resources, i.e. CPU, Memory and Disks

Programming Languages Topics:

1. Programming Languages Evaluation Criteria.
2. Describing Syntax and Semantics.
3. Lexical and Syntax Analysis.
4. Subprograms: Referencing, Overloading, Parameter-passing.
5. Imperative Programming Paradigm.
6. Functional Programming Paradigm.
7. Logic Programming Paradigm.

Recommended References:

1. Siblerschatz and Galvin, Operating System Concepts, Ninth Edition, 2014, Wiley.
2. Distributed Operating Systems, Tanenbaum Andrew, http://www.e-reading.me/book.php?book=143358
3. Concepts of Programming Languages, R. Sebesta, 10th Edition, Addison Wesley.

Area C: "Security and Net-centric Computing"

Security and Net-centric Computing Topics:

1. Fundamentals of Computer Networks and the Internet
2. Network Applications: Architectures, Protocols and Systems
3. Network Applications: Architectures, Protocols and Systems
4. Transport Layer: Congestion and Flow Control, Protocols
5. Network Layer: Addressing, Routing Algorithms, Protocols
6. Data Link Layer: Framing, Error Control, Medium Access Control, LANs
7. Computer and Network Security: Basics, Malicious Software, Intrusions, Firewalls, VPNs, Network Layer Security Protocols
8. Cryptography: Symmetric and asymmetric ciphers
9. Message Integrity and Digital Signatures
10. Entity Authentication and Key Management
11. Web Application Security
12. Physical Security

Recommended References:

1. Computer Networking: A Top-Down Approach, 6/e, J. Kurose & Keith Ross, Addison Wesley, 2013. http://www.pearsonhighered.com/kurose-ross/
2. B. A. Forouzan, Cryptography and Network Security, McGraw Hill 2007. http://highered.mheducation.com/sites/0072870222/index.html

Area D: "Software Engineering"

Software Engineering Topics:

1. Software Development Processes
2. Software Requirements Engineering
3. Software Architecture
4. Software Design Strategies and Methods
5. Software Quality Analysis and Evaluation
6. Software Maintenance
7. Testing Process and Techniques
8. Quality Assurance
9. Software Project Management

Recommended References:

1. "Software Engineering", Ian Sommerville, Addison-Wesley; 9th edition, 2011, ISBN-10: 0137035152
2. "Software Engineering: A Practitioner's Approach", Roger S Pressman and Bruce R. Maxim, 8th edition, 2014, ISBN: 0078022126