Topics for PhD program: Computer Science

Courses: Principles of Programming Languages, Computer Organization and Architecture, Data Structures & Algorithms, Introduction to Computer Networks, Database Systems, Operating System, Introduction to Artificial Intelligence, Calculus, Linear Algebra, Probability & Statistics

Principles of Programming Languages

1. Introduction to Programming Languages
2. Syntax and Semantics
3. Lexical Analysis and Parsing
4. Data Types
5. Control Structures
6. Memory Management
7. Procedural Programming
8. Object-Oriented Programming (OOP)
9. Functional Programming
10. Concurrency and Parallelism
11. Programming Paradigms and Language Design

Textbook: Sebesta, R. W. (2016). *Concepts of Programming Languages* (11th ed.). Pearson.

Computer Organization and Architecture

1. Introduction to Computer Systems
2. Data Representation and Number Systems
3. Computer Arithmetic
4. Basic CPU Organization
5. Instruction Set Architecture (ISA)
6. Memory Hierarchy and Organization
7. Input/Output Organization
8. Control Unit Design
9. Pipelining and Superscalar Architecture
10. Multiprocessor and Multithreading Systems

Textbook: Patterson, D. A., & Hennessy, J. L. (2013). *Computer Organization and Design: The Hardware/Software Interface* (5th ed.). Morgan Kaufmann Publishers.

Data Structures & Algorithms

1. Introduction to Data Structures and Algorithms
2. Arrays and Strings
3. Linked Lists
4. Stacks and Queues
5. Trees
6. Heaps
7. Hashing
8. Graph Algorithms
9. Sorting Algorithms
10. Dynamic Programming

Textbook: Lafore, R. (2002). *Data Structures and Algorithms in Java* (4th ed.). Sams Publishing.

Introduction to Computer Networks

1. Network Fundamentals
2. OSI and TCP/IP Models
3. Physical Layer and Transmission Media
4. Data Link Layer
5. Network Layer
6. Transport Layer
7. Application Layer
8. Routing and Switching
9. Network Security
10. Wireless Networks

Textbook: Kurose, J. F., & Ross, K. W. (2016). *Computer Networking: A Top-Down Approach* (7th ed.). Pearson.

Database Systems

1. Introduction to Databases
2. Database Models
3. SQL and Query Processing
4. Database Design
5. Indexing and Hashing
6. Transaction Management
7. Query Optimization
8. Database Security
9. Distributed Databases
10. Big Data and NoSQL

Textbook: Silberschatz, A., Korth, H. F., & Sudarshan, S. (2019). *Database System Concepts* (7th ed.). McGraw-Hill Education.

Operating Systems

1. Introduction to Operating Systems
2. Processes and Process Management
3. Threads and Concurrency
4. CPU Scheduling
5. Synchronization and Deadlock
6. Memory Management
7. File Systems
8. Input/Output Systems
9. Protection and Security
10. Distributed Systems and Cloud Computing

Textbook: Silberschatz, A., Galvin, P. B., & Gagne, G. (2018). *Operating System Concepts* (10th ed.). Wiley.

Introduction to Artificial Intelligence

1. Introduction to AI
2. Search Algorithms (Uninformed and Informed)
3. Knowledge Representation
4. Problem Solving and Heuristics
5. Machine Learning Basics (Supervised, Unsupervised)
6. Neural Networks (Introduction)
7. Natural Language Processing (Basics)
8. Computer Vision (Introduction)
9. Expert Systems and Rule-based Systems

Textbook: Russell, S., & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson.

Calculus

1. Limits and Continuity
2. Derivatives and Differentiation
3. Applications of Derivatives
4. Integration and Antiderivatives
5. Applications of Integrals
6. Techniques of Integration
7. Sequences and Series
8. Multivariable Calculus
9. Differential Equations
10. Vector Calculus

Textbook: Stewart, James. *Calculus*. 8th ed., Cengage Learning, 2015.

Algebra

1. Vectors and Vector Spaces
2. Matrices and Matrix Operations
3. Systems of Linear Equations
4. Linear Transformations
5. Eigenvalues and Eigenvectors
6. Orthogonality and Inner Product Spaces
7. Diagonalization and Spectral Theorem
8. Singular Value Decomposition (SVD)
9. Quadratic Forms
10. Jordan Canonical Form

Textbook: Strang, G. (2016). *Introduction to Linear Algebra* (5th ed.). Wellesley-Cambridge Press.

Probability & Statistics

1. Introduction to Probability
2. Probability Rules and Theorems
3. Random Variables

4. Probability Distributions (Discrete and Continuous)
5. Expectation and Variance
6. Sampling and Sampling Distributions
7. Statistical Inference
8. Confidence Intervals
9. Hypothesis Testing
10. Regression and Correlation

Textbook: Devore, J. L. (2019). *Probability and Statistics for Engineering and the Sciences* (9th ed.). Cengage Learning.