



# CAPITAL UNIVERSITY OF SCIENCE & TECHNOLOGY ISLAMABAD

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## PhD Comprehensive Examination – Spring 2022 (Faculty of Computing)

### PhD Computer Science

### General

S. No.	Subject	Duration of Written Paper	Max Marks
1	Design & Analysis of Algorithms	40 Minutes	50
2	Operating Systems	40 Minutes	50
3	Theory of Computation	40 Minutes	50
4	Computer Architecture	40 Minutes	50
5	Programming (DS+OOP+DB)	80 Minutes	100
Total: -		240 Minutes (04 Hours)	300

Minimum pass percentage is 60 % in written part.

### Syllabus for Computer Science

Subject Name: Design & Analysis of Algorithms	
<b>Relevant Book:</b> Introduction to Design & Analysis of Algorithms By Anany Levitin (Third Edition)	
<b>Objectives:</b>	
1	Analyze the time and space complexity of different algorithms by using standard analysis techniques
2	Understand different algorithm design techniques and their relative advantages in order to select a better algorithm to solve a problem
<b>List of Topics:</b>	
Sr No	Topic
1	Introduction
2	Analysis of Algorithm Efficiency
3	Brute Force and Exhaustive Search

4	Decrease-and-Conquer
5	Divide-and-Conquer
6	Transform-and-Conquer
7	Space and Time Trade-Offs
8	Dynamic Programming
9	Greedy Technique
10	Limitations of Algorithm Power
11	Coping with the Limitations of Algorithm Power
12	Useful Formulas for the Analysis of Algorithms

<b>Subject Name: Operating Systems</b>	
<b>Relevant Book:</b> Operating System Concepts By Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne (Ninth Edition)	
<b>Objectives:</b>	
1	Understand fundamental operating system abstractions such as processes, threads, files, semaphores, IPC abstractions, shared memory regions, etc.
2	Analyze important algorithms e.g. process synchronization, CPU scheduling, deadlock management and memory management.
<b>List of Topics:</b>	
<b>Sr No</b>	<b>Topic</b>
1	Introduction
2	Operating System structures
3	Processes
4	Threads
5	Process synchronization
6	CPU scheduling
7	Deadlocks
8	Main Memory
9	Virtual memory
10	Virtual machines
11	Distributed systems

<b>Subject Name: Theory of Computation</b>	
<b>Relevant Book:</b> Introduction to Languages and the Theory of Computation (4 <sup>th</sup> Edition) By: John C. Martin	
<b>Objectives:</b>	
1	Build different types of automata to define formal languages
2	Prove decidability and reducibility of computational problems
3	Analyze time complexity of a Turing Machine
<b>List of Topics:</b>	
<b>Sr No</b>	<b>Topic</b>
1	Finite state automata
2	Regular expressions
3	Context-free grammars

4	Push-down automata
5	Turing machines;
6	Recursively enumerable languages; Chomsky's hierarchy
7	Turing decidability and reductions
8	Turing computability;
9	Time complexity of a TM; Complexity classes

<b>Subject Name: Computer Architecture</b>	
<b>Relevant Book:</b> Computer Organization & Architecture, Designing for Performance By William Stalling (11 <sup>th</sup> Edition 2019)	
<b>Objectives:</b>	
1	Understand the functionality of major components of a computer system.
2	Understand principles of instruction set design
3	Understand pipelining and parallelism features applied in modern systems.
<b>List of Topics:</b>	
Sr No	Topic
1	Introduction and Basic Concept
2	The Memory Hierarchy: Locality and Performance
3	Cache Memory
4	Internal Memory
5	External Memory
6	Input/Output
7	Parallel Processing
8	Multicore Computers

<b>Subject Name: Programming (DS+OOP+DB)</b>	
<b>Sub Domain:</b> Data Structures	
<b>Relevant Book:</b> "Data structures and algorithm analysis." 3 <sup>rd</sup> Edition By Shaffer, Clifford A.	
<b>Objectives:</b>	
1	Understand the design of fundamental data structures
2	Implementing different data structures in a programming language
3	Analyze data structures according to their typical uses, strengths, and weaknesses
Sr No	Topic
1	Data Structures and Algorithms
2	Linked Lists: Singly Linked Lists, Doubly Linked Lists, Circular List
3	Stacks
4	Queues
5	Trees: Binary Trees, Binary Heap, Binary Search, Tree Traversal, Insertion, Deletion, and Balancing a Tree; Heap; B-Tree; Spanning Tree, Splay Trees, Searching Revisited: Red-Black trees, AVL trees, General n-ary trees
6	Sorting Algorithms: Insertion Sort, Selection Sort, Bubble Sort, Shell Sort, Heap Sort, Quick Sort, Merge Sort, Radix Sort, Bucket Sort
7	Hashing

8	Indexing
9	Graphs: Representation, Traversal, Graph Traversal Algorithms Depth-First Search, Breadth-First Search, Topological Sort Shortest Path, and Cycle Detection; Isomorphic Graphs;
10	List and Arrays
<b>Sub Domain:</b> Object Oriented Programming	
<b>Relevant Book:</b> Lafore, Robert. Object-oriented programming in C++. Pearson Education, Fourth Edition	
<b>Objectives:</b>	
1	Describe key concepts of object-oriented programming paradigm
2	Interpret real world problems in terms of objects rather than procedure
3	Apply object-oriented programming principles to implement programs
<b>Sr No</b>	<b>Topic</b>
12	Loops and Decisions: For Loop, While Loop, Do While Loop, Precedence: Arithmetic and Relational Operators, Switch Statement, Conditional Operator, Control Statements
13	Structures and Enumerations
14	Functions, Reference Arguments, Overloaded Functions, Recursion, Inline Functions, Scope and Storage Class, Returning by Reference
15	Class and Objects, Overloaded Constructors, Static Class, const and Classes
16	Encapsulation
17	Arrays and Strings, Arrays as Class Member Data, The Standard C++ string Class
18	Operator Overloading
19	Association
20	Inheritance and Generalization: Derived Class and Base Class, Overriding Member Functions, Public and Private Inheritance, Multiple Inheritance
21	Aggregation: Classes Within Classes
21	Composition
23	Pointer
24	Virtual Functions
25	Polymorphism
26	Abstract Class
27	Friend Class
28	Dynamic Binding
29	Templates and Exception
30	OOP Software Development
<b>Sub Domain:</b> Database Systems	
<b>Relevant Book:</b> Database Systems, A Practical Approach to Design Implementation and Management, Pearson Education ,6th Edition	
<b>Objectives:</b>	
1	Acquire the basic concepts and uses of databases with different applications
2	Describe and apply different stages of database development
3	Identify function dependencies and resolve database anomalies
<b>Sr No</b>	<b>Topic</b>
31	Logical Database Design
32	Conceptual Database design
33	Normalization
34	Relational Algebra
35	Transaction Processing

# **PhD Mathematics**

## **Syllabus for Mathematics**

All students will have to attempt six (6) papers out of the topics listed below. Each paper shall have fifty (50) max Marks and shall be of duration of 40 Minutes.

Minimum pass percentage is 60 % in written part.

<b>List of Courses</b>		
1	MT5643	Applied Cryptography
2	MT5123	Advanced Mathematical Analysis
3	MT5023	Advanced Wave Mechanics
4	MT5013	Advanced Partial Differential Equations.
5	MT5213	Advanced Numerical Techniques
6	MT5043	Advanced Ordinary Differential Equations
7	MT5353	Abstract Algebra
8	MT5243	Finite Difference Methods
9	MT5143	Advanced Functional Analysis
10	MT5543	Computational Fluid Dynamics
11	MT5043	Electromagnetic Wave Theory
12	MT5233	Finite Element Methods
13	MT5813	General Relativity
14	MT5053	Celestial Mechanics