

**School of Information Technology**  
**IIT Kharagpur**

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**Rules for Ph.D. Comprehensive Examination**

**Schedule of the examination:**

The Ph.D. qualifier examination will be held once in every semester (early September in Autumn semester and mid March in Spring semester). It will be an examination of duration 4 hours.

**Eligibility:**

Students are permitted to appear comprehensive examination after completion of one semester.

**Examination:**

The comprehensive examination will be held in the form of written test only. The examination consists of one paper having two parts: Part A and Part B each of 50 marks.

Part A has the following content: Data Structures, Algorithms and Programming

Part B has three groups. Students will have to answer question from any one of the groups. They have to select the group in advance and communicate the same to the Ph.D. coordinator at the time of expressing their desire to appear for the qualifier examination. The three groups are as follows:

- Group I: Information Systems
- Group II: Networks
- Group III: Computing Systems and Signals

**Qualifying the Examination:**

A student has to score at least 60% in the examination in order to pass the Comprehensive examination. A student has to clear the Comprehensive examination in at most two attempts failing which his (or her) name will be struck off the PhD rolls of the Institute and he (or she) can work leading to MS degree.

## **Syllabus for the Ph.D. Comprehensive Examination**

### **Part A: Data Structures, Algorithms and Programming**

#### Data Structures:

- Linked lists, Stacks, Queues, Trees, Binary search tree, Height balanced tree - Red-black tree, Heap

#### Algorithms:

- Asymptotic notation and complexity analysis; Recurrence relations and their solution
- Searching algorithms: Linear search, Binary search, Hashing
- Sorting algorithms: Bubble sort, Insertion sort, Merge sort, Quick sort, Heap sort, Counting sort
- Basic notions of algorithm design techniques: Greedy, Divide-and-conquer, Dynamic programming
- Graph representations and Graph algorithms: BFS, DFS, Minimum spanning trees, Single-source shortest path

#### Programming:

(A student can choose to write programs in any of the three languages: C/C++/Java)

- Basics of Programming: Input/Output, Control flows, Functions, Arrays, Structures, Pointers, Recursive functions

### **Part B (any ONE group from the following)**

#### **Group I: Information Systems**

##### Software Engineering:

- Software process and process models, Requirements analysis and specification
- Software design processes: Function-oriented design with data flow diagrams, Object oriented modeling using Use-Case diagram and Class diagram
- Software testing: Black box, white box and grey box testing strategy. Testing techniques: Unit testing, Integration testing and System testing
- Software cost estimation – COCOMO

##### Database Management Systems:

- Entity relationship diagrams, Integrity constraints, Relational algebra, Normalization – 1NF, 2NF, 3NF and BCNF
- Indexing techniques: B-Tree and B+ Tree.
- Transactions – ACID properties
- Recovery and Concurrency control – Conflict and view serializable schedules

## **Group II: Networks**

- Basics of data communication: Spectrum and Bandwidth of signals, Attenuation and Noise, Nyquist rate, Bit rate, Capacity of a channel - Nyquist and Shannon limits
- Encoding techniques: NRZ, NRZ-L, Manchester, Differential Manchester, Multiplexing techniques (TDM and FDM), Synchronous and Asynchronous communications
- Flow control: Stop-and-wait, Sliding window, ARQ techniques - Stop-and-wait, Go-back-N, Selective-Repeat
- Data link layer issues: Framing, Contention protocols – CSMA, CSMA/CD, Ethernet, CSMA/CA
- Network layer issues: Routing protocols - Flooding, Random routing, Distance vector and link state protocols, IPv4 - addressing, fragmentation
- ARP, Subnetting
- Transport layer issues - TCP (basic operation), Flow control, Congestion control, UDP (basic operation)
- Basics of wireless LANs: IEEE 802.11 architecture, BSS, ESS, access points, medium access control.
- Application layer protocols: Telnet, SMTP, POP3, HTTP
- DNS, Concepts of proxy and firewall, Security – Basics of symmetric key and public key cryptosystems, digital signature, digital certificates, IPSec, SSL

## **Group III: Computing Systems and Signals**

### Digital Logic:

- Switching theory - Boolean algebra, logic gates, and switching functions, truth tables and switching expressions, minimization of switching functions, Karnaugh map
- Combinational logic circuits - Realization of Boolean functions using gates and multiplexers
- Sequential m/c model - Flip-flops, basic design of counters

### Computer Organization and Architecture:

- Instruction set architecture: Instruction types, Addressing modes
- Arithmetic: Representation of fixed and floating-point numbers, 2's complement arithmetic
- Control unit: Organization of a CPU, Register-transfer level specifications
- Memory system: Memory organization, Types of memory, Concept of memory hierarchy, Cache memory
- Types of interrupts and interrupt handling
- Input-output systems: Interrupt-driven I/O, Polling, Basic concepts of DMA transfer

### Signals:

- Classification of signals
- A/D and D/A conversion
- Analysis of discrete time Linear time invariant (LTI) systems
- Correlation of discrete time signals
- Z-transform and its application to LTI systems
- Frequency analysis of continuous and discrete time signals
- Discrete Fourier Transform: Its properties and applications