Software engineering syllabus

Software engineering examinations

Group A - Compulsory examinations (eight required)

19-Soft-A1 Algorithms & Data Structures

Fundamental data structures and their associated algorithms. Stacks and queues, trees, tables, lists, arrays, strings, sets; files and access methods. B-trees, multi-key organizations. Searching, Sorting. Algorithm design techniques, such as divide and conquer, the greedy method, balancing, dynamic programming. Algorithms related to set operations, Graphs, graph algorithms: depth-first and breadth-first search, minimum spanning tree, shortest path. Empirical and theoretical measures of the efficiency of algorithms. Complexity analysis. Hard problems, NP-completeness, and intractable problems.

Textbooks (most recent edition is recommended):

19-Soft-A2 Computer Architecture and Operating Systems

Computer Architecture basics, including Boolean algebra, gates, combinational and sequential logic, machine-level representation of data; machine organization, assembly/machine language programming; memory organization, caches, heaps, stacks; serial and parallel I/O, interrupts, bus protocols, and direct memory access (DMA). Operating System basics, including concurrency, process scheduling, memory management; protection, access, and authentication; linking and loading; virtual machines.

Textbooks (most recent edition is recommended):
- Saltzer and Kaashoek, *Principles of Computer System Design: An Introduction*

19-Soft-A3 Software Design


Textbooks (most recent edition is recommended):

19-Soft-A4 Real-Time Systems

Definition and characteristics of real-time systems. Hard and soft real-time systems. Dynamic responses of simple physical processes. Designing real-time systems (requirements, design methods, implementation, testing, human-computer interaction). Reliability and fault tolerance. Exceptions and exception handling. Concurrency, synchronization, communication and resource control. Scheduling (cyclic executive, rate monotonic and deadline priority, priority ceiling
protocols). Real-time operating systems. Simple embedded systems.

Textbooks (most recent edition is recommended):

19-Soft-A5 Requirements and Specifications

Elicitation sources and techniques. Modelling paradigms, including information modelling, behavioural modelling, domain modelling, functional modelling, constraint modelling. Quality requirements (e.g., performance, usability, reliability, maintainability); expressing quality requirements so that they are testable. Prioritization, trade-off analysis, negotiation, risk analysis, and impact analysis. Requirements management, consistency management, interaction analysis, traceability. Requirements documentation (e.g., use cases) and specification languages. Validation, reviews and inspections, prototyping, validating non-functional requirements. Acceptance test design.

Textbooks (most recent edition is recommended):

19-Soft-A6 Software Quality Assurance

Validation and verification concepts, software lifecycle and application of validation and verification, software quality assurance processes. Definitions of software product quality, quality characteristics, engineering quality definitions, specifications. Definition and classifications of software defects, fitness for use and customer quality definitions. Software costs, quality costs and economics. Reviews, walkthroughs and inspections. Unit (Module/Package) level testing, subsystem/integration testing, regression testing, state based testing, traditional functional testing, logical testing/analysis, OO testing considerations (polymorphism and inheritance). Safety/failure analysis and testing.

Textbooks (most recent edition is recommended):

19-Soft-A7 Software Development Process


Textbooks (most recent edition is recommended):

21-Soft-A8 Discrete Mathematics

Logic: propositional equivalences, predicates and quantifiers, sets, set operations, functions, sequences and summations, the growth of functions. Algorithms: complexity of algorithms, the integers and division, matrices. Methods of proof: mathematical induction, recursive definition.

Textbooks (most recent edition is recommended):

- No Referenced Textbooks

**Group B - Optional examinations (three required)**

19-Soft-B1 Advanced Software Design

Software design paradigms: object-oriented, service-oriented, component-based, agent-based, functional programming, client-server (including protocols such as REST), virtualization. Distributed component-based frameworks and systems. Design patterns. Model-driven design of software. Software architecture. Architecture representation.

Textbooks (most recent edition is recommended):


19-Soft-B2 User interface


Textbooks (most recent edition is recommended):


19-Soft-B3 Security

Security risks, threats, and vulnerabilities. Confidentiality, integrity, and privacy. Cryptography, access control, assurance, accountability. Engineering of secure systems, architectural approaches (e.g., confinement, virtual machines, trusted computing). Analysis techniques (e.g., static analysis and testing, model checking). Implications on human interface design and usability.

Textbooks (most recent edition is recommended):


19-Soft-B4 Dependable systems

Textbooks (most recent edition is recommended):

19-Soft-B5 Software Modeling & Verification (Formal Methods)

Mathematical modelling of software, including topics such as programming logics, process algebras, model based specification, object constraint languages, and algebraic specification. Mathematical reasoning using such models, including proofs of program correctness. Tools for static checking of the correctness of software relative to its specification.

Textbooks (most recent edition is recommended):

19-Soft-B6 Software Project Management


Textbooks (most recent edition is recommended):
- No Referenced Textbooks

19-Soft-B7 Reverse Engineering, Maintenance & Evolution


Textbooks (most recent edition is recommended):
- No Referenced Textbooks

19-Soft-B8 Distributed Systems


Textbooks (most recent edition is recommended):
- No Referenced Textbooks

19-Soft-B9 Parallel Computing

Textbooks (most recent edition is recommended):

- No Referenced Textbooks

19-Soft-B10 Networking and Communications


Textbooks (most recent edition is recommended):


19-Soft-B11 Process Control Systems


Textbooks (most recent edition is recommended):

- No Referenced Textbooks

19-Soft-B12 Engineering Computation: Numerics


Textbooks (most recent edition is recommended):


19-Soft-B13 Performance Analysis & Simulation

Basic techniques of system performance evaluation. Specific topics include: measurement methods and tools, experimental design and analysis, modeling (including queuing and network of queuing systems), discrete event simulation, verification and validation of simulation models, analysis of simulation output, statistical methods (comparing systems using sample data, hypothesis testing and confidence measures).

Textbooks (most recent edition is recommended):


19-Soft-B14 Safety Critical Systems

Textbooks (most recent edition is recommended):

19-Soft-B15 Artificial Intelligence


Textbooks (most recent edition is recommended):

19-Soft-B16 Programming Languages, semantics and implementation


Textbooks (most recent edition is recommended):

19-Soft-B17 Data Visualization


Textbooks (most recent edition is recommended):