Nepal Rastra Bank
Syllabus for
Assistant Director (IT/Cyber Security)
Open Competition

Stages of Examination

1. **First Stage:** Written Examination   **Full Marks: 300**

Paper	Subject	Full marks	Pass marks	Types of questions	Time
Paper I	Information Technology – I	100	40	**Objective* & Subjective**	**Total 3 hrs**: 30 min. for Objective and 2 hrs. 30 min. for Subjective
Paper II	Information Technology - II	100	40		**Total 3 hrs**: 30 min. for Objective and 2 hrs. 30 min. for Subjective
Paper III	IT Security	100	40		**Total 3 hrs**: 30 min. for Objective and 2 hrs. 30 min. for Subjective

*0.2 marks will be deducted for each incorrect answer

2. **Second Stage:** a) Practical   **Full Marks: 50**   **Pass Marks: 25**
                           b) Interview   **Full Marks: 40**

Remarks:

1. In written examination, questions shall be asked in English.
2. Examinee shall use English language in answer.
3. Theoretical, practical and analytical questions will be asked.
4. During the first stage written examinations, subjective question paper will be distributed only after collecting objective answer sheets (candidates have to submit the answer sheets within the allocated time period for objective exam).
5. Candidates shall write their answers of MCQs, short questions and long questions on separate answer sheets.
6. The candidates selected from the written examination will be called for the second stage.
7. This syllabus would be applicable from August 17, 2022.

Paper I
Information Technology – I

There shall be 30 multiple-choice questions, 8 short-answer questions and 3 long-answer questions with 1, 5 and 10 marks each respectively. Subjective exam will be conducted immediately after the submission of objective answer sheets by the candidates within allocated time period. Candidates are required to answer all of them

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1. **Computer Architecture & Organization and Microprocessors**

   1.1. Basic Structures: Sequential Circuits, Design Procedure, State Diagram, and State Table, Von Neumann / Harvard Architecture, RISC/CISC Architecture, SISD, SIMD, MISD, MIMD, Representation of data, Arithmetic Operation, Basic Operational Concepts, Bus Structure, Instruction, Cycle and Excitation Cycle

   1.2. Processing Unit: Instruction Format, Arithmetic Formats, Arithmetic and Logical Instruction, Addressing Modes and Formats, address instructions (one, two and three)

   1.3. Input Output Organization: I/O programming, Memory Mapped I/O, Basic Interrupt handling systems

   1.4. Computer Arithmetic: Arithmetic and Logic Unit, Integer Arithmetic and Representation, Floating-Point Arithmetic

   1.5. Memory Systems: Internal Memory, Cache Memory, Direct Memory Access, External Memory

   1.6. CPU Structure and Function: Processor and Register Organization, Power PC Processor

   1.7. 808X and Intel Microprocessor : Programming and Interfacing , Microinstruction Sequencing and Execution

2. **Digital Logic Design**

   2.1. Digital Logic: Basic, Exclusive and Universal Gates, Positive and Negative Logics

   2.2. Analog and Digital systems

   2.3. Combinational Logic Circuits: Boolean Algebra, K-Map, Minterms and Maxterms, SOP and POS

   2.4. Data Processing Circuits: Adders and Subtractors, Multiplexer and Demultiplexer, Encoders and Decoders, Parity Generators and Checkers, Comparators, ROM and PLDs

2.5.   Arithmetic Circuits: Binary Addition, Subtraction, Signed- and Unsigned Numbers

2.6.   Flip-flops: Latches and Flip-flops, SR, D, T and JK Flip-flops, Flip-flop Conversion, Characteristic Equations, Excitation Tables, Master-slave Flip-flops Registers: Different Types of Flip-flops, SISO, SIPO, PISO, PIPO

2.7.   Counters: Synchronous Counters, Asynchronous Counters, Up/Down Counters, Modulus Counters, Decade Counters, Digital Clock

2.8.   Sequential Machines: Synchronous Machines with Single and Multiple Serial Inputs, Synchronous Machines Design using Different types of Flip-flops, Asynchronous Machine Design Examples

3. Operating Systems

3.1.   Fundamentals of Operating System (OS): Definition, Development and Functions of Operating System, Functional Architecture of OS, Types of OS, Network and Distributed OS

3.2.   Processes and Threads: Symmetric Multiprocessing, Micro-kernels, Concurrency, Mutual Exclusion and Synchronization, Inter Process Communications, Semaphores. Features of Process Scheduling; List of the features of Inter-Process Communication and Deadlock scheduling

3.3.   Disk Allocation and Scheduling Methods, Basic Memory Management strategies, Virtual Memory Management Techniques, Definition of a Process and Features of the Process Management System

3.4.   Concepts of Parallel and Distributed Processing, Security Threats to Operating Systems, authentication and access authorization, system flaws and attacks, trusted system

3.5.   Input Output and Files: I/O devices and its organization, Principles of I/O software and hardware, Disks, Files and directories organization, File System Implementation, Interrupt handling

4. Database Management System and Design

4.1.   Fundamentals of DBMS: Iintroduction, Database Model, Relational Database Model, Functional dependency, Integrity, RDBMS, Data Mining and Data Warehousing

4.2.   SQL and Embedded SQL: Writing Basic SQL Queries (DDL, DML, DCL), SQL middleware basics: SQL API, Open SQL Gateway, Restricting and Sorting Data, Sub

Queries, Manipulating Data and Creating &Managing Tables, Creating Views and Controlling User Access, Using Set Operators, Date time Function

4.3. Relational Database Design, ER Diagram, Data Flow diagram (DFD), Keys (primary, foreign, candidate, alternate keys), Normalizations (1NF, 2NF, 3NF, BCNF, 4NF) and functional dependencies, Basic Concept of major RDBMS products (MSSQL, Oracle, MariaDB etc.), Concept of Time series DB

4.4. Fundamentals of database servers, functions, procedures, triggers and rules

4.5. Transaction Management and Concurrency Control: Concurrent execution of the user programs, transactions, Concurrency control techniques

4.6. Crash Recovery: Types of Failure, Recovery Techniques

4.7. Query Processing and Optimization

4.8. Indexing: Hash based indexing, Tree based indexing

4.9. Concept of Distributed Database Systems and Object-oriented database system

4.10. Concepts of SQL and noSQL databases

5. **Computer Networks**

5.1. Definition, OSI & TCP/IP reference model, Topologies, Client/Server Model & Peer2Peer Model, Network Components: Repeater, Hub, Bridge, Switch, and Router

5.2. Link Layer: Services, Flow and Error Control, error detection and correction, multiple access protocols (ALOHA, Slotted ALOHA), 802.3 Ethernet CSMA/CD, Token Bus, FDDI, Protocols: PPP, HDLC, Virtual circuit switching: Frame relay, ATM, X.25, MPLS

5.3. Network Layer: services, datagram and virtual circuits, routing principles and algorithms, Internet Protocols (IPv4/v6) header format, IPv4/v6 addressing and sub-netting, VLSM, CIDR, ICMPv4/v6 error/information messages, Routing: interior/exterior routing, unicast/multicast routing, adaptive/non-adaptive routing. Routing protocols i.e., RIP, OSPF, BGP, IS-IS

5.4. Transport Layer: Services, multiplexing and De-multiplexing, UDP, TCP, flow control, TCP sliding window, principles of congestion control, TCP congestion control, Open/close loop congestion control, Leaky bucket & Token Bucket algorithm, overview of socket programming, TCP/UDP Sockets

5.5. Upper layers: Application, presentation and session layer functionalizes, principles of WWW, DNS, DHCP, FTP, email protocols: SMTP/PoP/IMAP, PGP

5.6. Network management: Server concepts-Proxy/Web/DNS servers, IP interconnection, Tier ISP architecture, VoIP, remote login (telnet, ssh), Traffic monitoring (MRTG, bandwidth, throughput, latency/delay)

5.7. Advanced Data Storage Techniques: Network Attached Storage (NAS), Storage Area Networks (SAN)

5.8. Introduction to Latest networking: Software-Defined Networking, Software-Defined IPv6 (SoDIP6) Network, IPv6 network migration methods, SDN migration methods, IoT, WSN, 5G networks and its migration

6. **Distributed System**

6.1. Fundamentals of Client server computing: Building blocks, the state of distributed client server infrastructure

6.2. Fundamental models of Distributed system, distributed object based communications: RPC/RMI, CORBA

6.3. Synchronization in Distributed System (DS), physical/logical clocks (Cristian, Lamport, Vector clocks), Distributed Mutual Exclusion, Election in DS

6.4. Replication and Fault Tolerant, Recovery approach in DS, Distributed file system (SUN-NFS, HDFS)

6.5. Distributed transaction and concurrency control methods, Distributed deadlock

7. **Emerging Technologies**

7.1. Basics of Cloud Computing, Characteristics, Cloud, Fog, Edge computing comparisons, Data Storage, Artificial intelligence (AI) and Security in, and of the Cloud

7.2. Cloud Technologies – Infrasture as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), and cloud services - Private, public, community hybrid-cloud

7.3. Virtualization: virtual machines and container technologies –i.e. Dockers, kubernetics

7.4. Ubiquitous Clouds and the Internet of Things

7.5. Virtual Currency: Concept, developments, models, risk and benefits, challenges

7.6. Concept of FinTech, RegTech and SupTech and underlying technologies

7.7. Concept of Application Programing Interface (API), IoT, Big Data, DLT, Smart contracts, QR Code and its applications

7.8.   Artificial Intelligence and Machine Learning: Introduction, Problem Decomposition and Planning, Logic and Reasoning, Natural Language Processing and ANN, Machine Learning and pattern recognition

7.9.   Basic concept of Decentralized Ledger Technology (DLT) and Digital assets

7.10. Concept of financial transaction interchange messaging systems such as ISO 8583, ISO 20222 etc.

8. **IT in Nepalese Financial Sector and related Act, Policy and Guidelines**

8.1.   Adoption of technology in Nepalese Banking Sector

8.2.   Payment System Provider, Payment System Operator,

8.3.   NRB Act, 2058

8.4.   Payment and Settlement Act, 2075

8.5.   Electronic Transaction Act, 2063

8.6.   ICT Policy, 2072

Chapter/ Unit	Multiple Choice Questions (MCQ)	Short Questions	Long Questions
1	3	1	
2	3	1	
3	5	1	1
4	6	1	1
5	5	1	1
6	2	1	
7	4	1	
8	2	1	
No. of questions	30	8	3
Marks	30×1=30	8×5=40	3×10=30
		Total 100	

Paper II
Information Technology – II

There shall be 30 multiple-choice questions, 8 short-answer questions and 3 long-answer questions with 1, 5 and 10 marks each respectively. Subjective exam will be conducted immediately after the submission of objective answer sheets by the candidates within allocated time period. Candidates are required to answer all of them.

1. **Programming Language**
    1.1.   Overview of Programming Language: History, Programming Paradigms, The role of Language translates in the Programming Process , Fundamental Issues in Language Design : Virtual Machines, Code Generation, Loop Optimization
    1.2.   Concept of Procedural Programming, Structural Programming, Object-Oriented Programming and Fundamentals of C/C++ programming
    1.3.   Java Programming for Declaration, Modularity and Storage Management Software Development, Java features, Difference between Java and C/C++, Java program structure
    1.4.   Service Oriented Architecture (SoA), Micro services, services based applications, and architecture

2. **Data Structure and Algorithms**
    2.1.   Fundamental of Data Structures, Abstract Data types
    2.2.   Linear data structure: Stacks, Queues, Lists, Linked Lists, Priority Queue
    2.3.   Trees: General and Binary Trees, Traversal, Implementations, Binary Search Trees, Balanced Search Trees, AVL Trees, 2-3 Trees, Red-black Trees
    2.4.   Indexing Methods, Hashing Trees, Suffix Trees
    2.5.   Time and space complexity, Bog O' Notation
    2.6.   Analysis of Simple Recursive and Non-recursive Algorithms
    2.7.   Searching, Merging and Sorting, Divide-and-Conquer, Dynamic Programming, Greedy Methods, Backtracking
    2.8.   Graph algorithms: Depth-first Search and Breadth-first Search, Shortest Path Problems, Minimum Spanning Trees, Directed Acyclic Graphs

3. **Theory of Computation**

   3.1. BNF, Language, Grammars

   3.2. DFA and NDFA, regular expression, regular grammar

   3.3. Closure, homomorphism

   3.4. Pigeonhole principle, pumping lemma

   3.5. CFGs, Parsing and ambiguity, Pushdown automata, NPDAs &CFGs

   3.6. Turing Machines

   3.7. Complexity Theory, P and NP

4. **Compiler Design**

   4.1. The Structure of a Compiler

   4.2. Lexical Analysis, Syntax analysis, semantic analysis

   4.3. Top down Parsing/ Bottom up Parsing

   4.4. Syntax Directed Translation

   4.5. Types and Type Checking

   4.6. Run-Time Storage Administration

   4.7. Intermediate Code generation, code generator, code optimization

   4.8. Architecture and recent development on compilers

5. **System Analysis and Design**

   5.1. Definition of the System, System Owner, System User, System Designers and system Builders, System Analysts, Variations on the System Analyst title, System development life Cycle

   5.2. Prototyping, Spiral, Waterfall, Rapid Application Development (RAD), Joint Application Development (JAD), DevOps, Agile development, Object oriented system development

   5.3. System Design Environment: Concept formulations

   5.4. Requirements analysis: Representing System Analysis Model, Requirement Model, Design Model

   5.5. Fundamentals of Object-oriented system analysis and design

   5.6.   Entity Relationship Diagram (E-R Diagram), Context Diagram, Data Flow Diagrams (DFDs), UML diagrams

6. **Software Engineering Principles**

   6.1.　Software process: The software lifecycle models, risk-driven approaches

   6.2.　Software Project management: Relationship to lifecycle, project planning, project control, project organization, risk management, cost models, configuration management, version control, quality assurance, metrics

   6.3.　Software requirements: Requirements analysis, requirements solicitation, analysis tools, requirements definition, requirements specification, static and dynamic specifications, requirements review

   6.4.　Software design: Design for reuse, design for change, design notations, design evaluation and validation

   6.5.　Software Project Implementation: Programming standards and procedures, modularity, data abstraction, static analysis, unit testing, integration testing, regression testing, tools for testing, fault tolerance

   6.6.　Software Maintenance: The maintenance problem, the nature of maintenance, planning for maintenance

   6.7.　Software cost estimation: COCOMO model

   6.8.　Tools and environments for software engineering, role of programming paradigm, process maturity and Improvement, ISO standards, SEI-CMM, CASE tools

7. **Web engineering and Programming**

   7.1.　Work Process Redesign (Reengineering) with Information Technology, IT Change management, Enterprise Resources Planning Systems, and Global Information Technology issues

   7.2.　Basics of Website Design, HTML, DHTML, XML, PHP, JavaScript, JS React

   7.3.　Code generators, CASE – use of automated tools to aid in the software development process, computer aided software engineering

   7.4.　Apps Development, Open source web application programming e.g. Android programming

8. **Computer Graphics**

   8.1.　Graphics concepts

   8.2.　Basic raster graphics algorithms and primitives

   8.3.　Scan conversion

   8.4.　2D geometrical transformations and viewing

8.5.   3D geometry and viewing

8.6.   Hierarchical modeling

8.7.   Projections

8.8.   Hidden surface removal

8.9.   Shading and Rendering

9.   E-Commerce, E-Governance and Underlying Technology

9.1.   Introduction to E-Commerce and M-Commerce, Electronic Commerce Strategies, Electronic Commerce Security Issues, Success Models of E-Governance

9.2.   E-Business and underlying technology: B2B, B2C, B2E, C2C, G2G, G2C

9.3.   Principles of Electronic Payment, Strategies & Systems

9.4.   E-marketing, Reverse Engineering, E-Banking, EDI Methods, SWIFT

9.5.   History of e-Governance development, e-Governance working principles, Models of e-Governance, Global trading environment & adoption of e-Governance

9.6.   G2G e-Governance; Governance to Business (G2B); Development of G2B Governance, E-Government life cycle, Infrastructure

9.7.   Online service delivery and electronic service delivery, Electronic funds transfer, e-payment gateways, Electronic payment system (EPS), Mobile Governance

Chapter/Unit	Multiple Choice Questions(MCQ)	Short Questions	Long Questions
1	4	1	1
2	4	1	
3	3	1	
4	2		
5	4	1	1
6	4	1	
7	3	1	
8	2	1	
9	4	1	1
No. of questions	30	8	3
Marks	30×1=30	8×5=40	3×10=30
Total 100			

Paper III
IT Security

There shall be 30 multiple-choice questions, 8 short-answer questions and 3 long-answer questions with 1, 5 and 10 marks each respectively. Subjective exam will be conducted immediately after the submission of objective answer sheets by the candidates within allocated time period. Candidates are required to answer all of them.

1. **Fundamental of Information Security/Cybersecurity**

   1.1. Introduction to cyber physical system

   1.2. Basics of Information Security: Confidentiality, Integrity, Availability, Non-Repudiation, Security technologies

   1.3. Cyber Security and information security, cyber threats, vulnerabilities and risk, Digital Forensics, Cybercrime and legal issues, cyber warfare, hacking, Digital Right management, Cyber threats landscape in financial sector, Blockchain technology and its advantages

   1.4. Cyber security frameworks i.e., NIST- Cyber security Framework (CSF), ISO 27001 & 27002, SOC2,

   1.5. Mobile Security & Common Vulnerabilities

   1.6. AI and ML for cybersecurity

2. **Network and System Security**

   2.1. Fundamental of network security, network protocols, Network attacks, Network security devices such as IDS, IPS, Firewall and its type, Firewall design, WAF, VPN, DMZ, NAT, Proxy Firewall, Wireless Security, Remote Access Security

   2.2. Authentication applications – Kerberos, electronic mail security, SSO

   2.3. OS Security, Patch management, Active Directory, Physical Security, Backup

   2.4. Identity and Access Management (IAM) and Cloud Access Security Broker (CASB)

   2.5. Security association database and security negotiation databases

3. **Software and Application Security**

   3.1. Security Principles in software development lifecycle, Database Security

   3.2. Web server, Browser, SSL/TLS, SET, Email Security

3.3. Example attack: Cross-site scripting, Cross-site request forgery, Out-of-bounds read, Input validation attack, Operating system (OS) command injection, SQL Injection, Use after free

4. **Security Models and Architecture**

   4.1. Security models and architecture, Systems evaluation methods – the orange book, rainbow series IT security evaluation criteria, common criteria etc.

   4.2. Lattice Model, State machine model, Bell-LaPadula Model, Biba Model, Clark-Wilson Model, Information Flow Model, Noninterference Model, Brewer and Nash Model, Graham-Denning model, Harrison-Ruzzo-Ullman model.

   4.3. Common security architecture frameworks: TOGAF, SABSA, OSA, IPSec

5. **Cryptography**

   5.1. Cryptography and Data Encryption Standard, Block Cypher Principle

   5.2. Symmetric key Cryptography-DES, AES, 3DES

   5.3. Asymmetric key Cryptography, Public key Cryptography: RSA algorithm, Elliptic-curve cryptography (ECC)

   5.4. Diffie-Hellman Key exchange, Number Theory-Prime and Relatively Prime Numbers, Message Digest, Hash Function,

   5.5. Message Authentication Code (MAC), digital signature and digital certificate, digital signature standards, authentication protocols

   5.6. Quantum Security: Quantum cryptography and Post-Quantum cryptography

6. **Hacking technique, tools and incident handling**

   6.1. Hacker techniques and tools, technical overview of hacking, foot printing, Scanning network, Malware and Worm controls, , Sniffing, Social Engineering, Denial of Service, Session, Hijacking, Incident Handling, Cloud Security and cyber kill chain

   6.2. Data leakage – data leak prevention, data at rest, data in motion, and data in use

   6.3. Data classification, Data inventory and discovery, Data ownership, data lifecycle (create-store-use-share-archive-destroy), Data discovery methodologies and Information Rights Management (IRM)

7. **Information Security and IS Risk Management**

   7.1. Access Control mechanisms and its type, Threats and Vulnerabilities, Security attacks, Authentication and Authorization, Password Management,

   7.2. System Hardening, Preventing cyber-attacks and threats

7.3. IS Audit, Vulnerability Assessment, Penetration Testing, Change management,

7.4. Disaster Recovery Fundamentals, Incident Handling

7.5. Information Systems risk; (1) risk identification, (2) risk assessment (3) risk response and mitigation, (4) risk and control monitoring and reporting.

8. **Information Security Law, Regulations and Policies and best practices**

8.1. Understanding of Policy, Guidelines, Standards and procedures

8.2. Domains of information security policy/cyber security policies

8.3. Legal issues in cybercrime

8.4. Ethics and Professionalism

8.5. NRB IT Guidelines 2012,

8.6. Professional Ethics, Intellectual Property Rights, Copyrights, Trademarks, Patents

8.7. Lawful intercept

8.8. Licenses & Agreements, Security policy best practices.

Chapter/ Unit	Multiple Choice Questions (MCQ)	Short Questions	Long Questions
1	4	1	1
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3	3	1	
4	3	1	
5	5	1	1
6	3	1	
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