Stream wise syllabus for Recruitment Exam for the Post of Scientific Assistant-A (Adv. No. NIELIT/NDL/2017/6)

(Computer Science)

1 Computer Science / Computer Engineering

1.1. Engineering Mathematics

Mathematical Logic: Propositional Logic; First Order Logic:

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniforms, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets, Relations, Functions, Groups, Partial Orders, Lattice, Boolean Algebra.

Combinatorics: Permutations, Combinations, Counting, Summation, generating functions, recurrence relations, asymptotics.

Graph Theory: Connectivity, spanning trees, Cut vertices & edges, covering, matching, independent sets, Colouring, Planarity, Isomorphism.

Linear Algebra: Algebra of Matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations, numerical solutions of non-linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, Maxima & Minima.

1.2 Computer Science/ Computer Engg

Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits, Number representation and computer arithmetic (fixed and floating point).

Computer Organization and Architecture: Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage.

Analog and Digital Communication: Autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems, amplitude modulation and

demodulation, angle modulation and demodulation, spectra of AM and FM, Super heterodyne receivers, circuits for analog communications, Information theory, entropy, mutual information and channel capacity theorem, Digital communications, PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

Programming and Data Structures: Programming in C, Functions, Recursion, Parameter passing, Scope, Binding, Abstract data types Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps, Object Oriented Programming Concepts- Object, Class, Inheritance, Polymorphism, Abstraction and Encapsulation.

Algorithms: Analysis, Asymptotic, notation, Notions of space and time complexity, Worst and average case analysis, Design; Greedy approach, Dynamic programming, Divide-and-conquer, Tree and graph traversals, Connected competent, Spanning trees, Shortest paths; Hashing, Sorting, Searching, Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concept of complexity classes –P, NP, NP-hard, NP-complete.

Theory of Computation: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability.

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

Operating System: Processes, Threads, Inter-Process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security,

Databases: ER-model, Relational Model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control.

Information Systems and Software Engineering: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Computer Networks: ISO/OSI stack, LAN technologies, Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), IP(v6), Application layer protocols, (ICMP, DNS, SMTP, POP, FTP, HTTP), Basic concepts of hubs, switches, gateways, and routers. Wireless technologies, Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

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(Adv. No. NIELIT/NDL/2017/6)

(Information Technology)

1. Engineering Mathematics

Mathematical Logic: Propositional Logic; First Order Logic:

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniforms, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets, Relations, Functions, Groups, Partial Orders, Lattice, Boolean Algebra.

Combinatorics: Permutations, Combinations, Counting, Summation, generating functions, recurrence relations, asymptotics.

Graph Theory: Connectivity, spanning trees, Cut vertices & edges, covering, matching, independent sets, Colouring, Planarity, Isomorphism.

Linear Algebra: Algebra of Matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations, numerical solutions of non-linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, Maxima & Minima.

2. Information Technology

Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits, Number representation and computer arithmetic (fixed and floating point).

Computer Programming: 'C' programming, Expressions and Console I/O, Statements, Arrays and Strings, Pointers, Functions, Structures, Unions, Enumerations, and Typedef, File I/O, Pre-processor and Comments

Object Oriented Techniques: Basics of Object Orientation, Basic Structural Modeling: Classes, Relationships, common Mechanisms, and diagrams, Object Oriented Analysis, Object oriented design, Object design, Combining three models, Introduction to Java, History, Features, Object Oriented concept of Java, Classes and Objects, Inheritance, Packages, Interface, abstract method, Polymorphism.

Data Structures And Algorithms: Linear Data Structures, Basic Analysis, Searching and Sorting, Algorithmic Strategies and problem solving, Non-Linear Data Structures, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.; Greedy approach, Dynamic programming, Divide-and-conquer, Tree and graph traversals, Connected competent, Spanning trees, Shortest paths; Hashing, Sorting, Searching.

Design and Analysis of Algorithms: Fundamental characteristics of an algorithm. Basic algorithm, Fundamental Algorithmic Strategies, Brute Force, Greedy method, Branch and Bound, Backtracking and Dynamic Programming, Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concept of complexity classes –P, NP, NP-hard, NP-complete, Graph and Tree Algorithms, Depth and Breadth first traversal, Tractable and Intractable Problems.

Information Management System(DBMS): ER-model, Relational Model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control

Operating Systems: Operating System Principles, Concurrency, Scheduling and Dispatch, Memory Management, File Systems, Deadlock, Security and Protection, Virtual Machines, Device Management, Linux/Unix

Computer Architecture And Organization: Basics of Digital Electronics, Register Transfer and Micro operations, Basic Computer Organization, Control Unit, Central Processing Unit, Computer Arithmetic, Input-Output Organization, Memory Unit, Introduction to Parallel Processing

Computer Networks: ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IPV4, IPV6, Application layer protocols, (ICMP, DNS, SMTP, POP, FTP, HTTP), Basic concepts of hubs, switches, gateways, and routers. Wireless technologies, Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

Software Engineering: Importance of Software and Software Evolution, Software Process models (Waterfall, Incremental, Evolutionary, Agile), CASE Tools and Environments, Requirements Engineering, Software Design, Software Construction, Software Verification and Validation, Software Quality Assurance, Formal Methods, Technical Metrics for Software, Software Cost Estimation, Software Project Management

Internet Web Programming: Working with User Interfaces, JAVA database connectivity-JDBC, Introduction to HTML Server side scripting Languages-JSP, I/O–AWT–Event handling–Introduction to Threads, Basics of Networking, TCP and UDP sockets, connecting to the Web, e-Commerce and e-Governance

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(Electronics)

1. Engineering Mathematics

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and Eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and Minima, Multiple integrals, Fourier series, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Strokes, Gauss and Green's theorems.

Differential Equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients. Method of variation parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorems, solution integrals

Probability & statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distributions, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

2. Electronics and Communication / Electronics and Telecommunication

Electronics Devices: Energy band in silicon, intrinsic and extrinsic semiconductors. Carrier transport in semiconductors, diffusion current, drift current, mobility and resistivity. Generation and recombination of carriers, p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-i-n and avalanche photo diode, basics of LASERs, Device technology, integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Small Signal Equivalent circuit of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifier. Amplifiers: single-and-multi-stage, differential and operational, feedback, and power. Frequency response of amplifiers. Simple op-amp circuits. Filters,

Sinusoidal oscillators, criterion for oscillation, single transistor and op-amp configurations. Function generators and wave-shaping circuits, 555 Timers. Power supplies.

Digital Circuits: Boolean algebra, minimization of Boolean functions, logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers, decoders. ROM, PROMS, Sequential circuits, latches and flipflops, counters and shift registers, Sample and hold circuits, ADCs, DACs, Semiconductor memories.

Signals and Systems: Definitions and properties of Laplace transform continuous-time and discrete-time Fourier series. Continuous-time and discrete-time Fourier transform, DFT and FFT, z-transform, Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeroes, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

Communications: Random signals and noise; probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem.

Digital Communication Systems: pulse code modulation (PCM), Differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matches filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA, CDMA and GSM. Wireless Communication.

Control Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems, transient and study state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis, root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integra-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

Electromagnetics: Elements of vector calculus; divergence and curl: Gauss and Stokes theorems, Maxwell's equations: differential and integral forms. Wave equations, Poynting vector. Plane wave: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristics and impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides : modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relation. Basics of propagation in dielectric waveguide and optical fibres. Basics of Antennas: Dipole antennas: radiation pattern; antenna gain.

Networks: Network graphs: Matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solutions methods: nodal and mesh analysis. Network theorems: superposition, Thevenin's and Norton's maximum power transfer, Star-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits. Solution of Network equations using Laplace transform, frequency domain analysis of RLC circuits, 2-port network parameters; driving point and transfer functions. State equations for networks.

Microprocessors & Micro controllers: Introduction to microprocessors and microcomputers: Function, architecture, programming of 8086 microprocessor , interfacing of RAM and EPROM, I/O addressing, I/O mapped I/O, and memory mapped I/O schemes, instruction execution, fetch/execute cycle, instruction timings and operation status.
Memory organization, program memory, data memory, direct & indirect addressing area, addressing modes, instruction set – arithmetic, logical and data transfer instructions. Machine cycles – interrupts, interrupt handling, single step operation, port bit latches and buffers, port structures and operation, accessing external memory. Timers, serial interface, I/O ports, timing, Microcontroller 8051 – Architecture, configurations, internal block schematic, program protection modes. I/O interfaces with microcontroller, Real Time Control Issues, Embedded Processing – Evolution, Issues and Challenges, Von Neumann, Harvard and their variants, Memory Architecture and Devices, Input, Output Devices and Mechanisms, PLA, PAL,PLDs.

Computer Architecture And Organization: Basics of Digital Electronics, Register Transfer and Micro operations, Basic Computer Organization, Control Unit, Central Processing Unit, Computer Arithmetic, Input-Output Organization, Memory Unit, Introduction to Parallel Processing