

Syllabus and Scheme of Written Examination for the Post of Junior Laboratory Assistant (Technical)- School of Computing and Electrical Engineering Advertisement No. IIT Mandi/Recruit./NTS/2024/03 dated 14.03.2024

There will be two-stage examination.

Stage I: Written Examination (Objective type) (100 MCQ questions)

Stage II: Skill/Trade Test

Syllabus of Stage-I:

There are four (04) specialization for the purpose of recruitment:

1. VLSI
2. CSE
3. SIGNAL PROCESSING AND COMMUNICATION
4. POWER

The prospective candidates are expected to choose one of the above specializations during the examination based on their qualification, experience and interest.

The syllabi of the above four (04) specializations are given below:

1. VLSI

Chapter 1: Electronic Devices Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors. Carrier transport: diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations. P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

Chapter 2: Analog Circuits Diode circuits: clipping, clamping and rectifiers. BJT and MOSFET amplifiers:

biasing, ac coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers. Op-amp circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

Chapter 3: Digital Circuits Number representations: binary, integer and floating-point numbers. Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders. Sequential circuits: latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay. Data converters: sample and hold circuits, ADCs and DACs. Semiconductor memories: ROM, SRAM, DRAM. Computer organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

Chapter 4: Electromagnetics Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector. Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth. Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart. Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays

2. CSE

1. Programming and Data Structures

- a. C/C++ Programming concepts: conditional statements, loops, etc.
- b. Elementary Data Types: Int, Float,
- c. Object oriented programming concepts
- d. Abstract Data Type: Linked Lists, Trees, Heaps, Graphs, etc.
- e. Searching Algorithms
- f. Sorting Algorithms g. MST and Graph Algorithms h. Time and Space Complexity analysis

2. Database and Web Technologies

- a. Basics of Database
 - b. RDBMs concepts
 - c. Normal Forms
 - d. Schemas
 - e. SQL on MySQL/MS Server/Oracle
 - f. JDBC/ODBC connectivity
 - g. Basic HTML tags
 - h. Front end designing: HTML tags and CSS
 - i. Backend designing (event based) using Java Scripts
 - j. Dynamic web page designing in PHP/ASP.NET/JSP etc.
- ### 3. Networking and Operating systems
- a. Basics of Network communication: OSI model, etc.
 - b. Various Protocols: HTTP, HTTPS, TCP/IP, UDP, ICMP protocols
 - c. Authentication and Authorization
 - d. Network devices and their functionality and uses e. Responsibilities of OS
 - f. User Interface
 - g. Types of OS: Network, Distributed
 - h. Various OS: DoS, GUI, Windows, Linux based OSs
 - i. System calls, Shell programming
 - j. Resource allocation and process management
 - k. Deadlock detection, prevention and avoidance algos l.

Other topics: Security, Files Systems and Storage, Networking m. Installation and configuration of the operating systems and local area networks. n. OpenPBS and The Slurm Workload Manager installation and configuration, job submission scripts, Creating clusters and network file systems

3. SIGNAL PROCESSING AND COMMUNICATION

Introduction to Signal Processing and Communication.

- Basic concepts of signals and systems.
- Types of signals: Analog vs Digital, Continuous vs Discrete.
- Communication systems overview: Transmitters, receivers, modulation, and demodulation.

Discrete-Time Signals and Systems.

- Discrete-time signals: Sampling, aliasing, and quantisation.
- Z-transform and its applications.
- Difference equations and system stability.
- Convolution and system response.

Fourier Transform and its Applications.

- Fourier series and Fourier transform: Continuous and discrete versions.

- DFT and FFT (Discrete Fourier Transform and Fast Fourier Transform).
- Applications: Spectral analysis, filtering in the frequency domain.

Communication Theory and Modulation Techniques.

- Analogue modulation: AM, FM, PM.
- Digital modulation: ASK, FSK, PSK, QAM.
- Bandwidth, power, and noise considerations in communication systems.
- Demodulation techniques.
- Practical modulation/demodulation experiments in MATLAB, Simulink, or hardware setups.

Random Processes and Noise Analysis.

- Basics of random signals and stochastic processes.
- Noise types: Gaussian noise, white noise, coloured noise.
- SNR (Signal-to-Noise Ratio) and its impact on communication.
- Noise modeling in MATLAB/Simulink.

Wireless Communication Systems.

- Introduction to wireless communication: Path loss, shadowing, fading.
- Multiple access techniques: FDMA, TDMA, CDMA.
- OFDM (Orthogonal Frequency-Division Multiplexing).
- MIMO (Multiple Input Multiple Output) systems.
- Practical wireless communication simulations using MATLAB/Simulink.
- 5G Technology and Beyond.
- IoT

4. POWER

- Three phase: Three phase emf generation, delta and star connections, balanced supply and balanced load, measurement of power in three phase circuits. Introduction to common earthing practices. Magnetic Circuits.
- Transformer: Constructional features, operating principle, emf equation, phasor diagram, equivalent circuit, open and short circuit tests, losses and efficiency.
- Power Converters: Buck, boost and buck-boost converters; continuous and discontinuous modes of operation; operation as single-quadrant, two-quadrant and four-quadrant choppers; basics of transformer isolated half-bridge and full-bridge converters.
- Uncontrolled rectifiers: Single phase bridge rectifier; centre-tapped rectifier; three phase bridge rectifier. Input side and output side performance; concept of AC input power factor under distorted waveforms.
- Controlled rectifiers: Some basic concepts regarding AC-DC phase controlled thyristor converters. AC to DC PWM rectifiers: Operation of a PWM bridge DC-AC inverter as an AC to DC PWM rectifier; application in renewable energy systems.
- Power Devices: Desirable switch characteristics; overview of available switches; power diodes /thyristors including GTOs; power MOSFETs / IGBTs; emerging power devices.

Important Instructions for candidates:

General information about the exam:

- The MCQs have negative marking for wrong answers. The unanswered questions will not be considered for evaluation. (*i.e.*, no marks will be awarded for any question not attempted).
- Only one best-suited answer has to be given for any MCQ. More than one answer will be treated as wrong answer.
- Use of only blue or black ballpoint pen is permitted to answer the questions and fill the form in the exam hall. Use of ink pen/gel pen/pencil/whitener is not permitted.
- Use of calculator, cell phones, log book, periodic table, and any type of electronic device etc., are strictly prohibited.
- The medium of instruction/answers will be English only.
- Involvement in any malpractices will lead to disqualification
- Any additional instructions given during the selection process must be adhered/complied.

Final Selection:

- Examinations for Stage-I and Stage-II will be conducted for all the candidates or as decided by the selection committee.
- Final selection will be made on the scores obtained in the Stage-I, as the Stage –II is of qualifying nature. But if a candidate fails to qualify in Stage-II, her/his candidature will not be considered further.
- Please note that for consideration in the merit list, a candidate has to secure minimum marks fixed by the selection committee in both exams at Stage-I and Stage-II – failing which institute will not make an offer of appointment even if vacancies go unfilled.