UNIVERSITY OF JAMMU

NOTIFICATION

Syllabus of Entrance/Screening Test for the post of Scientific Officer, USIC

Total Marks: 100 **Time: 2:00 Hours**

S.No.	Examination Type	Section	Units	Marks	Duration
1.	Multiple Choice Questions	A	General English, General Knowledge, Logical Reasoning, Basic Arithmetic, Analytical Ability etc.	30	2:00 Hours
2.	Multiple Choice Questions	B	Discipline Oriented	70	

SECTION-A

I. General English, General Knowledge, Logical Reasoning, Basic Arithmetic, Analytical Ability etc.

SECTION-B

Unit I: Fundamentals of Instrumentation

- **Principles of Measurement**:
  - Generalized measurement system: input, transduction, signal processing, output stages.
  - Mechanical, electrical, optical, and pneumatic measurement systems.
- **Transducers and Sensors**:
  - Classification: resistive, inductive, capacitive, piezoelectric, thermoelectric, optical, magnetic.
  - Sensors for physical parameters: displacement, velocity, acceleration, force, torque, pressure, flow, temperature, level, strain, vibration, and humidity.
  - Smart transducers and digital sensors.
- **Performance Characteristics**:
  - Static: accuracy, precision, sensitivity, resolution, hysteresis, drift, linearity.
  - Dynamic: time constant, frequency response, bandwidth.
- **Signal Conditioning & Processing**:
  - Amplification, filtering, modulation/demodulation, isolation, noise reduction.
  - Analog-to-digital and digital-to-analog conversion, sampling theorem.
  - Introduction to Lab VIEW, MATLAB/Simulink in instrumentation.
- **Calibration & Standards**:
  - International system of units, calibration methods, primary vs. secondary standards.
  - Traceability, uncertainty estimation, error classification.

Unit II: Mechanical Systems and Design

- **Strength of Materials & Design Considerations:**
  - Stress, strain, Hooke's law, elastic and plastic deformation.
  - Failure theories, creep, fatigue, fracture mechanics in scientific instruments.
  - Materials selection for precision and laboratory instruments (alloys, composites, ceramics).

- **Dynamics of Machines & Vibration Analysis:**
  - Free and forced vibrations, damping, resonance in rotating machinery.
  - Balancing of shafts, rotors, and precision components.
- **Heat Transfer in Instruments:**
  - Modes of conduction, convection, radiation.
  - Design of heat exchangers, thermal insulation, cooling mechanisms for sensitive equipment.
- **Mechanical Components in Instrumentation:**
  - Bearings, gears, couplings, seals, pumps, valves, pressure vessels.
  - Precision machining, tolerances, alignment, lubrication and tribology.
- **Design Tools & Techniques:**
  - Computer-Aided Design/ Computer-Aided Manufacturing (CAD/CAM) for scientific instrument design.
  - Finite Element Analysis (FEA) for stress, thermal, and vibration studies.
  - Rapid prototyping and 3D printing for laboratory applications.

Unit III: Electronics and Control Systems

- **Electronic Devices & Circuits:**
  - Semiconductors, diodes, transistors, operational amplifiers, instrumentation amplifiers.
  - Power supplies, signal conditioning circuits.
- **Digital Electronics & Embedded Systems:**
  - Combinational and sequential logic circuits, Analog-to-Digital Converter / Digital -to-Analog Converter (ADC/DAC) interfacing.
  - Microcontrollers (Arduino, PIC, ARM Cortex), basics of Field-Programmable Gate Array (FPGA).
  - Embedded C programming for instrument control.
- **Control Systems:**
  - Modeling of dynamic systems, transfer functions.
  - Time and frequency domain analysis.
  - Proportional–Integral–Derivative (PID), feedforward, adaptive, and fuzzy control applications.
- **Industrial Automation & Robotics:**
  - Programmable Logic Controller and Supervisory Control and Data Acquisition (PLCs and SCADA) systems.
  - Robotic manipulators and machine vision in laboratory automation.
- **Signal Transmission & Communication:**
  - RS-232/485, GPIB, Modbus, CAN bus, USB, Ethernet.
  - Wireless protocols: Zigbee, Bluetooth, Wi-Fi, IoT communication.
  - Cybersecurity basics in connected instruments.

Unit IV: Scientific Instrumentation and Maintenance

- **Core Scientific Instruments:**
  - Optical: spectrophotometers (UV-Vis, IR), XRD, microscopes (light, AFM, SEM, TEM).
  - Analytical: chromatography (HPLC, GC), mass spectrometry, NMR.
  - Electrical/Electronic: Digital storage oscilloscopes, function generators, spectrum analyzers.
  - Mechanical: centrifuges, balances, pumps, furnaces, autoclaves.
- **Biological and Biochemical Instrumentation:**
  - PCR (Polymerase Chain Reaction) machines – principle, operation, applications.
  - ELISA readers and washers – working principle, troubleshooting.
  - Refrigerators, deep freezers, cold rooms – design, maintenance, calibration.

- Incubators, laminar flow hoods, biosafety cabinets.
- **Support & Utility Systems:**
  - Vacuum systems (rotary, diffusion, turbomolecular pumps).
  - Cryogenics (LN_2, He systems).
  - High temperature and pressure systems.
- **Maintenance & Reliability Engineering:**
  - Preventive, predictive, and corrective maintenance.
  - Condition monitoring techniques: vibration analysis, thermography, oil analysis.
  - Root cause and fault-tree analysis for instrument failures.
- **Laboratory Safety & Compliance:**
  - Electrical, chemical, and biological safety practices.
  - ISO/IEC laboratory standards and GLP (Good Laboratory Practices).
  - Risk assessment, fire safety, emergency protocols.

Unit V: Emerging Technologies and Applications

- **Smart Sensors and IoT in Instrumentation:**
  - Wireless sensor networks, IoT-enabled lab monitoring systems.
  - Cyber-physical systems and cloud-based instrumentation.
- **Advanced Instrumentation:**
  - Micro-Electro-Mechanical Systems / Nano-Electro-Mechanical Systems (MEMS/NEMS), nano-instrumentation.
  - Lab-on-chip, microfluidics.
  - Biomedical instrumentation: ECG, EEG, CT, MRI, ultrasound basics.
- **Artificial Intelligence and Data Analytics:**
  - AI/ML in fault diagnosis, predictive maintenance.
  - Big data in experimental sciences.
  - Digital twins for monitoring laboratory instruments.
- **Energy and Sustainability Applications:**
  - Instrumentation for solar, wind, biomass energy systems.
  - Smart grids and energy efficiency instrumentation.
- **Case Studies in Research Instrumentation:**
  - Space, nuclear, defense, and material sciences.
  - Role of scientific officers in multidisciplinary university research labs.

REGISTRAR 13/5/26

No. Estab./C&R/NTW/26/600
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