3. Examination

3.2 CSIR NET / JRF

Council of Scientific and Industrial Research (CSIR) NET (also known as CSIR UGC NET) is a national-level exam conducted by the **National Testing Agency (NTA)** to determine the eligibility of candidates for Junior Research Fellowship (JRF) and for Lectureship (LS)/ Assistant Professor in the universities and colleges of India. Candidates clearing the CSIR NET exam can become lecturers in the subject areas falling under the faculty of Science & Technology only.

Subject Code : PHYSICAL SCIENCE – 705

Schedule : **CSIR NET / JRF is conducted twice in a year,** i.e,. **in the month of June and December.** The notications announcing in the employment news.

Syllabus

CSIR-UGC National Eligibility Test (NET) for Junior Research Fellowship and Lectureship

PHYSICAL SCIENCES

P AR T - A

I. Mathematical Methods of Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

II. Classical Mechanics

Newton’s laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamicsmoment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativityLorentz transformations, relativistic kinematics and mass–energy equivalence.

III. Electromagnetic Theory Electrostatics

Gauss’s law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel’s law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

IV. Quantum Mechanics

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigen value problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

V. Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.

VI. Electronics and Experimental Methods

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics. Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting.

PART – B ADVANCED

I. Mathematical Methods of Physics

Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge Kutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

II. Classical Mechanics

Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

III. Electromagnetic Theory

Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

IV. Quantum Mechanics

Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

V. Thermodynamic and Statistical Physics

First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

VI. Electronics and Experimental Methods

Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).

VII. Atomic & Molecular Physics

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

VIII. **Condensed Matter Physics Bravais lattices**.

Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

IX. Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semiempirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-

particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

Eligibility

The basic CSIR UGC NET eligibility criteria that candidates must fulfil are mentioned below:

Educational Qualification

- Candidates should have obtained a degree in BTech / BE / BPharma/MBBS/BS (four years)/Integrated BS-MS/MSc with a minimum of 55 per cent marks for General (UR)/General-EWS and OBC (50 per cent for SC/ST, Third gender and PwD).

Age Limit

- To apply for CSIR NET JRF, candidates should be a maximum of 28 years of age. The upper age limit is relaxable for up to 5 years for SC/ST/Third gender / PwD / Females and up to 3 years for OBC (Non-Creamy Layer)
- There is no upper age limit to apply for the post of Lectureship (LS)/ Assistant Professor

Notification

Online registration	: March 2023 to April 2023
Admit card	: June 2023
Exam Date	: June 2023
Declaration of Result	: July 2023
Mode of Exam Online	: CBT (Computer-Based Test)
Exam Fees	: INR 1,000 for the General category, INR 500 for OBC and INR 250 for SC/ ST.

Exam Pattern

I. You have opted for English as medium of Question Paper. This Test Booklet contains seventy five **(20 Part 'A' + 25 Part 'B' + 30 Part 'C')** Multiple Choice Questions (MCQs). You are required to answer a maximum of 15, 20 and 20 question from part 'A', 'B' and 'C' respectively. If more than required number of questions are answered, only first 15, 20, 20 questions in Parts **'A', 'B' and 'C'** respectively, will be taken up for evaluation.

II. Each question in Part 'A' carries 2 marks, Part 'B' 3.5 marks, Part 'C' 5 marks respectively.

There will be negative marking @ 25**% (Part 'A' 0.50 marks, Part 'B' 0.875 marks and Part 'C' 1.25 marks)** for each wrong answer.

Exam Time : Shift 1 - 09:00 am to 12:00 noon

or

Shift 2 - 03:00 pm to 06:00 pm

Application Form

The candidates interested to appear in CSIR NET 2023 are required to fill out the application form for the same. Candidates should follow the given below steps to accurately fill out the CSIR NET Application Form 2023.

1. At first, the candidates are required to get themselves registered online.
2. Login with the credentials used during the registration process.
3. Fill out the application form available with the application number & password shared on your email id and phone number.
4. Upload the scanned documents as per requirements. The instructions for the same will be available there.
5. After submitting the form, pay the application fee through the online payment gateways available.

Recruitment Process

The complete recruitment process for the CSIR NET exam is explained below:

Step One : Filling up the CSIR NET Application Form

Step Two : CSIR NET Exam 2023

Step Three : Announcement of CSIR NET 2023 Result

The **CSIR NET result** is declared in two categories-

1. One merit list who qualifies for the award of Junior Research Fellowship (JRF-NET).
2. The second merit list is for the candidates who qualify for the eligibility test for lectureship (LS-NET).

Step Four: Interview

The next phase of the selection process is an interview. Qualified candidates, who will be shortlisted on the basis of the merit list will have to face personal interviews in different institutions, laboratories and University departments.

Step Five: Award of Fellowship