SYLLABUS FOR THE POST OF
JUNIOR SCIENTIFIC ASSISTANT (BALLISTICS) in FSL

1. FORENSIC SCIENCE

Forensic Science Unit : Introduction, Need, Scope, Concepts and Significance of Forensic Science, History and Development of Forensic Science, Laws and Basic principles of Forensic Science, Branches of forensic science, Organizational set-up of a Forensic Science Laboratory. Investigative strategies. Expert testimony and eye-witness report.

Tools and techniques in Forensic Science : Basic principles of microscopy, spectroscopy, chromatography.

Forensic Photography: Basic principles of Photography. Crime Scene & laboratory photography.

Crime Scene Management: Crime scene investigations, protecting and isolating the crime scene; Documentation, sketching, field notes and photography. Searching, handling and collection, preservation and transportation of physical evidences. Chain of custody and Reconstruction of scene of crime Report writing.

Glass : Types of glass and their composition, Forensic examinations of glass fractures.

Tool marks: Types of tool marks- compression marks, striated marks, combination of compression and striated marks, repeated marks, class characteristics and individual characteristics, tracing and lifting of marks, skid marks and their analysis. Restoration of erased / obliterated marks- Method of making-cast, punch, engrave; methods of obliteration, method of restoration- etching (etchings for different metals), magnetic, electrolytic etc., recording of restored marks – restoration of marks on wood, leather, polymer etc.

Criminal Laws: Related to Forensic Ballistics; Arms Act and Arms rules .

Explosives: Classification of explosives, synthesis and characteristics of Tri-nitro toluene (TNT), Pentaerythritoltetranitrate (PETN) and Research and Development Explosives (RDX).Explosion process, blast waves, searching of scene of explosion. Post blast residue collection and analysis, blast injuries and detection of hidden explosives. Improvised explosive devices.

Forensic Ballistics: History and background of Firearms, their classification and characteristics, various components of small arms, smooth bore and rifled firearm, different systems. Projectile velocity determination, Theory of recoil, methods for measurement of recoil. Techniques of dismantling/assembling of firearm. Types of ammunitions, classification and constructional features of different types of cartridges, types of primers and priming composition, propellants and their compositions, velocity and pressure characteristics under different conditions. Identification of origin, improvised/ country-made/ imitative firearms and their constructional features.

(a) Internal and External Ballistics: Definition, ignition of propellants, shape and size of propellants, manner of burning, various factors affecting the internal ballistics: lock time, ignition time, barrel time, erosion, corrosion and gas cutting, equation of motion of projectile, principal problems of exterior ballistics, Introduction to automated system of trajectory computation and automated management of ballistics data.

(b) Terminal Ballistics: Effect of projectile on hitting the target: function of bullet shape, striking velocity, striking angle and nature of target, Tumbling of bullets, effect of instability of bullet, effect of intermediate targets, influence of range, anti-mortem firearm injuries.

(c) Examination and identification: Firearms, ammunition and their components identification and examination, different types of marks produced during firing process on cartridge-firing pin marks, breech face marks, chamber marks, extractor and ejector marks and on bullet number/direction of lands and grooves, striation marks on lands and grooves, identification of various parts of firearms, techniques for obtaining test material from various types of weapons and their linkage with fired ammunition, class and individual characteristics, determination of range of fire-burning, scorching, blackening, tattooing and metal fouling, shots dispersion and GSR distribution, time of firing – different method employed, and their limitations, stereo & comparison microscopy, automatic bullet and cartridge comparison system. GSR analysis : Mechanism of formation of GSR, source and collection, spot test, chemical test, identification of shooter and instrumental methods of GSR Analysis, Management and reconstruction of crime scene; suicide, murder and accidental and self defence cases.

Atomic & Molecular Spectroscopy: Spectroscopy, electromagnetic spectrum, sources of radiation, their utility and limitations. Elements of X-ray spectrometry, fluorescence, energy dispersive X-ray analysis (EDX).

Physical instrumentation techniques: IR spectroscopy- correlation of infrared spectra with molecular structure, fourier transform, infrared (FTIR) and Raman spectroscopy, fluorescence and phosphorescence spectrophotometry, Ultra violet and visible spectrophotometry.

Atomic absorption spectrometry: Instrumentation and techniques, interference in AAS.
Radiochemical and Nuclear techniques: Basic principles, theory and instrumentation, Mass Spectrometry, GCMS, LCMS.

Medico legal aspects of death: Death: Signs of death and changes after death. Somatic death, molecular death ,early changes after death - Algor mortis, rigor mortis, cadaveric spasm.

2. MATHEMATICS/ APPLIED MATHEMATICS

Linear Algebra: Vector spaces over R and C, linear dependence and independence, subspaces, bases, dimensions, Linear transformations, rank and nullity, matrix of a linear transformation, Algebra of Matrices; Row and column reduction, Echelon form,

congruence and similarity; Rank of a matrix; Inverse of a matrix; Solution of system of linear equations;.

Calculus: Real numbers, functions of a real variable, limits, continuity, differentiability, mean-value theorem, Taylor's theorem with remainders, indeterminate forms, maxima and minima, asymptotes; Curve tracing; Functions of two or three variables; Limits, continuity, partial derivatives, maxima and minima.

Ordinary Differential Equations: Formulation of differential equations; Equations of first order and first degree, integrating factor.

Dynamics and Statics: Rectilinear motion, simple harmonic motion, motion in a plane, projectiles; Constrained motion; Work and energy, conservation of energy; Kepler's laws, orbits under central forces, Equilibrium of a system of particles; Work and potential energy, friction, Common catenary; Principle of virtual work; Stability of equilibrium, equilibrium of forces in three dimensions.

Vector Analysis: Scalar and vector fields, differentiation of vector field of a scalar variable; Gradient, divergence and curl in cartesian and cylindrical coordinates; Higher order derivatives; Vector identities and vector equations.

Real Analysis: Real number system as an ordered field with least upper bound property; Sequences, limit of a sequence, Cauchy sequence, completeness of real line; Series and its convergence, absolute and conditional convergence of series of real and complex terms, rearrangement of series.

Partial Differential Equations: Family of surfaces in three dimensions and formulation of partial differential equations.

Mechanics and Fluid Dynamics: Generalised coordinates; D'Alembert's principle and Lagrange's equations; Hamilton equations; Moment of inertia; Motion of rigid bodies in two dimensions, Equation of continuity; Euler's equation of motion for inviscid flow; Stream-lines, path of a particle; Potential flow; Two-dimensional and axisymmetric motion; Sources and sinks, vortex motion; Navier-Stokes equation for a viscous fluid.

3. PHYSICS

Mechanics

(a) Mechanics of Particles:
Laws of motion; conservation of energy and momentum; applications to rotating frames; centripetal and Coriolis accelerations; motion under a central force; conservation of angular momentum; Kepler's laws; fields and potentials; gravitational field and potential due to spherical bodies; Gauss and Poisson equations; gravitational self-energy; two-body problem; reduced mass; Rutherford scattering; centre of mass and laboratory reference frames.

(b) Mechanics of Rigid Bodies:
System of particles; centre of mass; angular momentum; equations of motion; conservation theorems for energy, momentum and angular momentum; elastic and inelastic collisions; rigid body; degrees of freedom; Euler's theorem; angular velocity; angular momentum; moments of inertia; theorems of parallel and perpendicular axes; equations of motion for rotation; molecular rotations (as rigid bodies); diatomic and triatomic molecules; precessional motion; top; gyroscope

Waves and Optics: Simple harmonic motion; damped oscillation; forced oscillation and resonance; beats; stationary waves in a string; pulses and wave packets; phase and group velocities; reflection and refraction from Huygens' principle, Geometric Optics, Interference, Diffraction, Polarisation and Modern Optics.

Electricity and Magnetism:

(a)Current Electricity:

Kirchhoff's laws and applications; Biot–Savart law; Ampere's law; Faraday's law; Lenz's law; self and mutual inductances; mean and rms values in AC circuits; DC and AC circuits with R, L and C components; series and parallel resonance; quality factor; principle of transformer.

Thermal and Statistical Physics:

(a) Thermodynamics:

Laws of thermodynamics; reversible and irreversible processes; entropy; isothermal, adiabatic, isobaric, and isochoric processes; Otto and Diesel engines; Gibbs phase ruleand chemical potential; Van der Waals equation; critical constants; Maxwell–Boltzmanndistribution; transport phenomena; equipartition and virial theorems; Dulong–Petit, Einstein and Debye theories of specific heat of solids; Maxwell relations; Clausius–Clapeyron equation; adiabatic demagnetization; Joule–Kelvin effect and liquefaction of gases.

(b) Statistical Physics:

Macro and microstates; statistical distributions; Maxwell–Boltzmann, Bose–Einstein, and Fermi–Dirac distributions; applications to specific heat and blackbody radiation; concept of negative temperatures.

Atomic and Molecular Physics: Stern–Gerlach experiment; electron spin; fine structure of hydrogen atom; L–S and J–J coupling; spectroscopic notation; Zeeman effect; Franck–Condon principle and applications; elementary theory of rotational, vibrational, and electronic spectra of diatomic molecules; Raman effect and molecular structure; laser Raman spectroscopy; importance of neutral hydrogen atom, molecular hydrogen and hydrogen ion in astronomy; fluorescence and phosphorescence; basic principles and applications of NMR and EPR; Lamb shift and its significance.

Solid State Physics, Devices and Electronics: Crystal and amorphous structures of matter; crystal structure determination; X-ray diffraction; electron microscopy; band theory of solids; conductors, insulators, and semiconductors; thermal properties of solids; specificheat; Debye theory; magnetic properties (dia, para, ferromagnetism); superconductivity; Meissner effect; Josephson junctions; applications of high-temperature superconductors. Intrinsic and extrinsic semiconductors; p–n junction; transistors; amplifiers and oscillators; operational amplifiers; FET, JFET, MOSFET; digital electronics (Boolean identities, De Morgan's laws, logic gates); simple logic circuits; thermistors; solar cells; fundamentals of microprocessors and digital computers.