PUNJAB PUBLIC SERVICE COMMISSION
BARADARI GARDEN, PATIALA-147001
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SYLLABUS FOR THE POSTS OF SCIENTIFIC OFFICER

SYLLABUS FOR SCIENTIFIC OFFICER (BALLISTICS)

Conventional Concepts of firearms: classification and characteristics, various components of small arms, smooth bore and rifled firearms.
Operational features of firearms: Barrel, body, Firing pin, Breech face, trigger, cork, and firing mechanism, measurement of strength of barrel & trigger pull.
Rifled Firearms: Caliber, Rifling, purpose of rifling, types of rifling and methods to produce rifling to produce rifling,
Smooth bore firearms: Bore, Choking& types of choking, Methods of choking purpose of choking, method of choking, purpose of choking.
Illegal firearms: AK-47, SKS and M16/AR15 Assault Rifles
Techniques of dismantling / assembling of firearm, improvised / country-made / imitative firearm and their constructional features.
Conventional Concepts of Ammunition: Types of ammunition- 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, various types of bullet and compositional aspects, latest trends in their manufacturing and design projectile, identification of origin, improvised ammunition and safety aspects for handling firearm and ammunition.

Core concepts of Internal 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, Density of loading, Pressure, Heat problems, Vibration & jump, Measurement of strength of firearm, projectile velocity determination, theory of recoil, methods for measurement of recoil.
Core concepts of External Ballistics: principal of external ballistics: vacuum trajectory, Trajectory Formation & its computation, effect of air resistance on trajectory, Angle of Fall, Influence of Earth on Trajectory, base drag, yaw, shape of projectile and stability, ballistics coefficient and limiting velocity, Ballistics tables, measurements of trajectory parameters, Escape velocity & Ricochet.

Core concepts of 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 Cavitations- Temporary and permanent cavities, Ricochet and its effects, stopping power

Wound Ballistics: Threshold velocity for penetration of skin/flesh/bones, preparation of gel block, penetrative in gel block and other targets, nature of wounds of entry, exit, initial with various ranges and velocities with various types of projectiles, explosive wounds, evaluation of injuries caused due to shot-gun, rifle, handguns and country made firearms, methods of measurements of wound ballistics parameters, post-mortem and anti-mortem firearm injuries. Determination of range of fire- burning, scorching, blackening, tattooing and metal fouling shots dispersion and GSR distribution, time offering different method employed, and their limitations, Bullet recovery, time of firing.

Gunshot Residues/ Powder Residues: Composition of GSR depending upon propellants & primer mixtures, GSR Distribution**,** Mechanism of formation of GSR, Location, source and collection of GSR, Analysis of GSR: spot test, chemical test, identification of shooter and instrumental techniques involved of GSR Analysis, Practical problems related with GSR detections.

Test firing, Procedure for test fire, Purpose for test firing, Recovery methodology, Specifications of Firing gallery, working of automatic firing rest, Safety & Preventive measures., Characterization of bullet proof jacket.

Principles and practice of identification of origin: ammunition and their components, different types of marks produced during firing process on cartridge- firing pin marks, breech face marks, chamber marks, extractor and ejector marks band 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.

Instrumental techniques used for ballistic evidence analysis: Boroscope, Comparison Microscope, Stereo microscope, traveling microscope, Neutron Activation analysis, Flameless AAS, Scanning Electron microscope, EDXRF.

Introduction to automated system of trajectory computation **(Ballistic Data Acquisition system)**: Operating system & its concepts, Universal Receiver, ICM, Target Frame.

Automated management of ballistics data **(Integrated Ballistics Identification system)**: History of establishment, Brass Trax, Bullet Trax & Match Point, Limitation & Advantages, Application-

SYLLABUS FOR SCIENTIFIC OFFICER (BIOLOGY)

Fundamentals of Forensic Biology
Introduction to Forensic Biology. History, Scope and applications of forensic biology. Biological evidence: Importance, nature, location, collection and evaluation.

Human Physiology and anatomy
Elements of human anatomy and physiology. Skeletal system, circulatory system, digestive system, respiratory system, nervous system, endocrine system, excretory system, reproductive system.

Anthropology and odontology
History, scope and development of forensic anthropology. Collection and preservation of evidences. Human osteology: Determination of age, sex, stature. Determination of personal identity by superimposition techniques: video image analysis, facial reconstruction. Legal provisions and tools involved. Examination and identification of mutilated bodies, fragmentary remains and bones. Their role in mass disasters. Determination of site, age, sex, race and species origin from bones and measurement of stature. Morphological, anatomical and microscopic examination of hair. Characteristics of hair to determine the species origin, race, sex and site.
Forensic odontology: Introduction, structure and types of teeth, dentition and dental formula, identification of person from teeth by their characteristics, alignment and overall structure of mouth.

Forensic Medicine
Introduction to Forensic Medicine. Legal Procedures, Inquests, Courts and their powers, and procedures in courts. Medico legal autopsy: A procedural out line of post mortem examination, rules for post mortem examination, disposal of dead body, post mortem examination report and opinions. Medico legal aspects of death – various causes of death, signs and symptoms of death , presumption of death and survivorship of death. Asphyxial deaths: Hanging, strangulation, throttling, suffocation, drowning. Identification of diatoms and its medico legal importance in drowning cases.

General and medico legal aspects of injuries/ traumatology
Mechanical Injuries: Abrasions, Bruises, Lacerations, Incised wounds, Stab wounds, Firearm injuries, Defense injuries, fabricated injuries. Traffic accident injuries: vehicular injuries, railway injuries and aircraft injuries. Thermal injuries: Burns and scalds, Lightning, Electricity, Explosions. Chemical trauma. Introduction to various types of sexual offences: unnatural and perversions, abortion, infanticide and their medico legal aspects.

Forensic Botany and wildlife.
Various types of woods. Varieties of timber, seeds, leaves and their identification. Study and identification of pollen grains, starch grains. Morphological and anatomical characteristics of plants yielding drugs of abuse like opium, Cannabis, Coca plant, Psilocybe mushrooms, Tobacco.
Wild Life Forensics**:** Introduction and importance of protected/endangered species of animals and plants. Wild life management and its economic value. Sanctuaries and its importance.

Different methods of killing and poaching of the wild life animals. Forensic methodologies to identify wild life animals: examination of physical evidences like hair, nails, teeth, ivory, horn, footprints (pugmarks) by conventional and modern methods. Wild life Protection Acts.

Forensic Microbiology and entomology

Different methods of sterilization. Introduction of food poison causing microorganisms and factors affecting its growth. Different methods for isolation of micro organisms from forensic samples like vomit, stool, stomach wash and residual food. Collection, Preservation and forwarding of samples. Biological warfare: Classification, Physical and Biochemical properties, toxic effects and detections.

Forensic Entomology: Introduction, general entomology and arthropod biology, insects of forensic importance, collection of entomological evidence during death investigations, the role of aquatic insects in forensic investigations, Insect succession on carrion and its relationship to determine time since death, its application to forensic entomology.

SYLLABUS FOR SCIENTIFIC OFFICER (SEROLOGY)

Blood

Blood: Composition and functions, blood collection and preservation, use of blood for species identification by various techniques like tube precipitation, gel diffusion techniques. Theories and biochemical tests for the identification of blood. Human blood groups: General principles and theory of their inheritance. Blood grouping from fresh blood, stains of blood, semen, saliva and other body fluids by various direct and indirect typing techniques (A, B and O grouping, Rh sub types, HLA typing, MN system). Signification of blood typing in establishing paternity and criminal investigations. Identification of menstrual blood, amniotic fluid and parturition stains. Application of various polymorphic enzymes and proteins in criminal investigation. Hemoglobin and its variants (Hbf-Hbs-Hbc-HbA). Forensic Examination of semen, saliva, urine, faeces, milk samples by various biochemical and chromatographic techniques.

Cell biology and Immunology

Introduction: Structure of prokaryotic and eukaryotic cell. Structure and function of nucleus, endoplasmic reticulum, Golgi complex, mitochondria, chloroplast and lysosomes, organization of nucleus and nuclear transport, three dimensional organization and functions of cytoskeletons (Microfilaments, intermediate filaments, microtubules and associated proteins)

Concept of innate (native) and acquired (adaptive) immunity. Introduction to immune response; Cells and organs of immune system, B-cells, T-cells and Null cells, antigen presenting cells, Antigen: Epitopes, factors affecting antigenicity, hapten and adjuvants. Antibodies: classes, physio-chemical properties and function of antibodies, raising of antisera, lectins and their forensic significance. Antigen – Antibody reactions and their techniques in serological analysis: Precipitin reaction, Agglutination reaction, Complement fixation reaction, Immunofluorescence, Enzyme Linked Immunosorbant Assay (ELISA), Radio Immunoassay (RIA); Radio-Allergo-Sorbent test (RAST). Determination of origin of species by immunological methods. Major Histocompatibility Complex (MHC) and Human Leucocyte Antigen (HLA). Introduction to immune disorders: autoimmune disorders, hypersensitivity and immunodeficiency.

Basics of DNA fingerprinting

History of DNA fingerprinting and DNA polymorphism. Application of DNA fingerprinting in forensic science. Basics of human genetics, Chemical structure of DNA and RNA. DNA as genetic material. DNA replication, transcription and translation. Biochemical regulation of gene expression. DNA modifying enzymes: Endonucleases, exonucleases, ligases. Mitochondrial DNA analysis in forensic investigation. DNA sequencing techniques, Non-human DNA and its analysis. New and future technologies: DNA chips, Single Nucleotide Polymorphism (SNP) analysis.

Forensic DNA Analysis

Procedure for collection and preservation of biological sample for DNA analysis. Genes and DNA markers. Techniques of DNA isolation and its quantification. Polymerase Chain Reaction (PCR). Single and Multiplex PCR. RFLP, RAPD, AFLP and PCR based techniques in DNA analysis. Y-STR analysis and its significance in establishing paternal relationships. DNA profiling of wildlife species and their forensic applications. Result of STR marker analysis and

its interpretation. Significance of match and statistical aspects. Introduction to online databases of forensic importance: BOLD. NCBI, STRbase, EXPASY, CODIS, NDNAD.

SYLLABUS FOR SCIENTIFIC OFFICER (TOXICOLOGY)

Poisons: Definition, classification, mode of action and factors affecting the poisoning, form of poisons, types of poisoning, medico-legal aspects in poisoning, methods of administration, Diagnosis and management of poisoning cases. Collection and preservation of viscera in fatal and survival cases. Submission of samples to the laboratory, and postmortem examination report/ findings study, specific analysis plan/ approach to toxicological examinations of poisoning samples, Classification of matrices

Forensic Toxicological Examination: Concepts, significance**,** Law relating to poisoning cases, visceral samples for toxicological examinations. Methods of extraction: Classical and Modern methods, Isolation and clean up procedures using conventional as well as modern techniques such as solid phase micro extraction technique.

Instrumental Techniques: Principle, instrumentation and forensic application of the following:
Microscopy: Comparison microscope, Phase contrast microscope, Stereoscopic microscope, Polarizing microscope, Fluorescence microscopy, IR microscopy, and Electron Microscope.
Spectroscopy: Ultraviolet and visible spectroscopy, Infrared Spectroscopy, Raman Spectroscopy, Flame emission spectrometry, Atomic absorption spectrometry Atomic Fluorescence Spectrometry and Mass Spectroscopy
Chromatography: Paper Chromatography, Thin Layer Chromatography, High Performance Thin Layer Chromatography, Gas Solid and/or Liquid Chromatography, Gas Chromatography – Head Space Technique, High Performance Liquid Chromatography, Gas Chromatography – Mass Spectroscopy, Gas Chromatography – Mass Spectroscopy – Mass Spectroscopy, High Performance Liquid Chromatography – Mass Spectroscopy and High Performance Liquid Chromatography – Mass Spectroscopy – Mass Spectroscopy,
Neutron Activation Analysis, X-Ray Techniques and Nuclear Magnetic Resonance

Analysis of Poisons: Inorganic poisons (cations and anions), Neutral poison (organic non volatile), Method of analysis of Basic drugs / poisons, Method of analysis of Acidic drugs / poisons, Method of analysis of metallic poisons and volatile poisons, Method of quantization of some volatile poisons including alcoholic beverages in biological materials. Analysis of samples taken under Food Adulteration Act.

Miscellaneous poisons: Insects and animal toxins and their examination. Plant poisons: Classification and characteristics, method of extraction and stripping of plant poisons in matrices and analysis by chemical and instrumental techniques.

Food Poisoning: Identification and cause of poisoning. Toxicological analysis of decomposed materials. Interpretation of toxicological findings and preparation of reports.

Forensic Pharmacology: Forensic pharmacological studies, absorption, distribution, pharmacokinetics and metabolism, pathways of drug metabolism, drug toxicity, excretion of drugs and poisons. Detection of poison on the basis of their metabolic studies, interpretation of analytical data and forming of opinion.

SYLLABUS FOR SCIENTIFIC OFFICER (PHYSICS)

Introduction to Physical evidences- General crime scene procedures-crime scene documentation-Crime scene searches- collection and preservation of physical evidences-

Introduction to glass, Types of glass and their compositions, Forensic examination of glass fractures under different conditions, physical matching, density comparison, physical measurements, Refractive index, Elemental analysis, Density gradient analysis, ignition loss, differential thermal analysis, elemental analysis of evidences. Determination of direction of impact: hackle marks, backward fragmentation, Physical measurements of glass, color and fluorescence, physical matching, density comparison, physical measurements, refractive index by refractometer, elemental analysis, and interpretation of glass evidence

Introduction to paints- Composition, Manufacture and Use of Paint, types of paint, Resins and binders, lacquers, Plasticizers, Water Based Polymers & Emulsions, Additives, solvents, Pigments Types, macroscopic and microscopic techniques for the characterization of Paint Fragments, pigment distribution, micro-chemical and solubility test, Pyrolysis technique for the Characterization and Discrimination of Paint, Use of Infrared Spectroscopy for the Characterization of paint Fragments, Scanning Electron Microscopy and Energy Dispersive X-ray analysis (SEM/EDS) for the Forensic Examination of Paints and Coatings, interpretation of Paint Evidences

Formation and types of soil, composition and color of soil, particle size distribution, turbidity test, microscopic examination, density gradient analysis, ignition loss, Differential Thermal Analysis (DTA), elemental analysis, interpretation of soil evidences

Restoration of erased/obliterated marks:

Importance of individual markings, Methods of marking-cast, engrave, punch, drill, welding etc, methods to obliterate numbers – Fundamental principle of restoration of marks, Restoration methods for metallic objects, plastic and other polymers, wood, leather, rubber, engraved markings, obliterated and re-painted numbers and its principles (Destructive and non-destructive), Preparation of etching reagents, Photography and assessment of all the methods for restoration of obliterated marks.

Tool mark Evidences

Introduction to tool marks, Types of tool marks(compression marks, striated marks, combination of compression and striated marks, repeated marks) Class characteristics and individual characteristics of tool marks, tracing, photography, lifting and casting of tool marks, photographic examination of tool marks, Identification and comparison of tool marks. Introduction to fibers, weaving pattern of fibers, Comparison of cut marks of fabric-Identification of ropes-Determination of tensile strength of fibers

Tyre Impressions

Introduction to tire impressions, Types of tires, Construction of tires, Nomenclature of tread and Information obtained from sidewall, Noise Treatment significance, Importance of tread wear indicators and retread tires **Tire Track Evidences-**Introduction to tire track, types of

evidences like track width, Wheelbase dimensions, Turning diameter, Tire positions in turn, Recovery of Tire Evidences by Photography, Casting of tire impressions, The examination process of tire impressions including identification and comparison, Case Studies

Lasers: Characteristics of laser light, Spontaneous emission, Stimulated emission, Stimulated absorption, Einstein coefficients, Population inversion and light amplification, Essential components of the laser, Ruby and He-Ne laser (principles only). Holography: Formation of a hologram, Reconstruction of the hologram, Requirements, Application In forensic investigation

X-rays: Production; continuous and characteristic X-rays and their spectra; Mosley's law; diffraction of X-rays by crystals; Bragg's law; Compton Effect**.**

Thermal Analysis: Principle theory and applications of Thermo gravimetric analysis, differential thermal analysis and differential scanning calorimetry.

Ion Selective Electrodes: Reference electrodes, metallic and membrane indicator electrodes, molecular selective electrodes, enzyme electrodes, biosensors and biochips-Inductively coupled plasma spectrography

Introduction to forensic engineering, ISI/Code of Building Construction, Structural failures, static loads, dynamic loads, causes of structural collapse, Types of cement and their composition, determination of adulterants by physical, chemical and instrumental methods, examination of brick, analysis of Bitumen & road materials, analysis of cement mortar and cement concrete & stones, forensic examination of electrical appliances installations, Characterization of materials by SEM

Voice analysis

Introduction to voice identification/speaker recognition and its forensic importance, History of voice analysis, Voice production theory, uniqueness in person's voice, interspeaker and intraspeaker variations, text-dependent and text-independent speaker recognition, Discriminating tests, closed test, Open test, Scope of voice analysis, collection of standards for comparison

Forensic Phonetics: introduction, ear witness identification, aural perceptual approaches, computer /machine approaches.

Handling of audio recording evidences & its physical examination, marking of speakers, Procedure for preparation of working copies

Speech signal processing, Components of speaker recognition- feature extraction, pattern matching and comparison, normalization techniques, speaker profiling, enhancement of speech signal/audio recordings, transcription and analysis of disputed utterances, establishing the authenticity and integrity of audio and video recordings

Approaches to speaker recognition- Segregation of Speech samples, auditory analysis/listener's approach, spectrographic approach or voiceprint analysis, automatic speaker recognition technique, phonetic Transcription, linguistic & phonetic analysis, acoustic parameters for examining speech samples, Temporal measurement, Fourier analysis, frequency & time domain representation of speech signal, analogue to digital conversion, fast Fourier transformation

Instrumental Analysis of speech sample: Verbatim, Clue words, IPA marking, CSL & Linear predictive coding technique, Examination using SPID.

Vocal behaviors-alcohol speech relationships- importance in forensic investigations, Report writing, Limitations, Precautions

Forensic Video analysis, Scope, Processing of video media, Capturing, Enhancement techniques, Specific frame analysis, Resolution, Image analysis, Biometric Analysis for Identification of Individual & Face recognition, Scope & its forensic application in the field of security.