

SYLLABUS
OF
FACT AND FACT
PLUS

NICFS National Forensic Sciences University
Delhi Campus,
Ministry of Home Affairs,
Government of India, Delhi

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SECTION : A

APTITUDE IN FORENSIC SCIENCE

For specialization subjects of Forensic Ballistics and Physical Sciences , Forensics Document Examination, Forensic Chemical Sciences, and Digital Forensics

- a) General knowledge, general English, aptitude and reasoning.
- b) Fundamentals of basic sciences as applied to forensic investigation.
 - i. Principles of the forensic science, disciplines of forensic science and their functions. Developments in forensic science in India and abroad. Scope of analysis in forensic science laboratories/institutions. Legendries and their contributions in the field of forensic science.
 - ii. Types of evidence materials in different type of crimes, source and significance of evidence material, tools and techniques in crime scene search, sketching, measurement, photography and videography. Identification, collection, preservation, packaging and forwarding of evidence materials. reconstruction of scenes of crime, lifting, developing and preserving fingerprints, footprints and tyre impressions and pattern evidence, Sampling, Chain of custody. Safety measures at the scene of crime and in laboratory.
- c) Quality Control and Quality Assurance in the analysis of evidence materials, Proficiency Test.
- d) Class and individual characteristics of material evidence. Techniques and instruments for evidence analysis: Electromagnetic radiations, Interaction of radiation with matter, Microscopy, Spectroscopy, Spectrophotometry, Chromatography, Electrophoresis, Components of Computer and their functions, Imaging of digital evidence and

authentication, Forensic photography. Precision, accuracy, error rate and standardisation.

- e) Basic Principles of Statistics – Probability, Mean, Median, Mode, F-Test, Chi-square Test, Measurement of uncertainty. Systematic and Random Sampling.
- f) Expert testimony in the Court of law. Admissibility of evidence, Laws, Acts, CrPC and IPC relevant to forensic science. Ethics in Forensic Science.

For specialization subject of Forensic Psychology

- a) Criminology, Psychology, Reasoning and Forensic Science

SECTION : B

ELECTIVE I: FORENSIC BALLISTICS AND PHYSICAL SCIENCES

i. Forensic Physics

1) General Guidelines for Physical Evidence Collection

Evidence collection from crime scene, victim & deceased in cases of - Homicide Investigation; Investigation of - Death due to fall from height, sexual offences and sex related homicide, Hanging (suicidal, accidental and homicidal), Paint, Glass, Soil, Fibre, Metals,

Sources of Exhibits, Goals of Evidence Packaging- Protection of Evidence from possible hazards; Elements of Packaging Evidence – Packing Material, Sealing of Evidence; Precautions, General Directions, Directions for Specific type of Exhibits – Weapons and tools, Hair and Fibres, Dust or Soil, Arson Cases and Cases of Burning, Tool Marks.

2) Analytical Instruments & Techniques of Forensic Physics

Microscope, Compound Microscope, Polarized Light Microscopy, Fluorescence Microscopy, Comparison Microscope, Stereo-zoom Microscope. Transmission Electron Microscope, Video-zoom Microscope. Scanning Electron Microscope – Energy Dispersive X-Ray. Atomic Force Microscope.

Introduction to spectrophotometry, Interaction of electromagnetic radiations with matter: phenomena of absorption, emission, reflection, fluorescence, phosphorescence.

Detection of radiations: Photographic detectors, thermal detectors, photoelectric detectors.

Basic concepts of atomic spectra, energy levels, quantum numbers, designation of states, selection rules, atomic spectra.

Ultraviolet and visible spectrophotometry: sampling devices, Lambert and Beers Law, calibration of instrument, Infrared spectrophotometry, High Resolution. Detectors. Atomic Absorption Spectrophotometry. rotational, vibrational and electronic spectra, spectra of polyatomic molecules.

Elements of X-ray spectrometry: Energy Dispersive X-ray Analysis (EDX), wavelength Dispersive X-ray analysis (WDX), X-ray diffraction, Auger emission spectroscopy and applications.

Radio chemical techniques: Basic principles and theory introduction about nuclear reactions and radiations, Neutron sources, Neutron Activation Analysis. Basics of Electrostatic

Effect of Chemical Structure and solvent on absorption spectra, qualitative and quantitative analysis and limitations. Applications in forensic chemistry and toxicology.

Infrared spectrophotometry: Basic principle, components, Sample handling, Dispersive and Fourier transform spectrophotometry, (FTIR). Qualitative analysis and interpretation of IR spectra, correlation of infrared spectra with molecular structure and applications in forensic chemistry and toxicology.

Raman Spectroscopy: Basic principles, Instrumentation, sample handling and illumination, structural analysis, polarization measurements and Dispersive & FT analysis and Applications in Forensic Chemistry and Toxicology. Advantage of Raman over IR and vice versa, Role of microscope.

Atomic Absorption Spectroscopy (AAS): Instrumentation, interference in AAS, background correction methods, graphite furnace quantitative analysis and applications. Detection limit and sensitivity.

Atomic Emission Spectroscopy (AES): Instrumentation and techniques, arc/spark emission, ICP-AES, comparison of ICP vs AAS methods, quantitative analysis, ESCA and its applications.

Fluorescence and phosphorescence spectroscopy: Types of sources, structural factors, instrumentation, comparison of luminescence and UV-visible absorption methods and applications.

Nuclear Magnetic Resonance Spectroscopy: Basic principles, theory and Instrumentation and applications.

3) Pattern Evidence

Tool marks- Types, Class and Individual Characteristics, Comparisons, Impression Marks, Compression Marks, Striated Marks, Combination of Impression and Striated Marks, Repetitive Marks, Materials for making Test Tool Marks, Methods of preparation of Test Tool Marks, Comparison of test and evidence tool marks, Rubber Stamp Impressions, Metallic Seal Impressions, Embossed Impressions and Indentation marks, Mechanical Impressions.

Cast, Engraved and Punched Marks – Methods of their restoration.

Glass: types of glass and their composition, manufacturing of various types of glass and their properties. Soil- Formation, Types, Composition and physical properties. Paints- Composition, Types, Manufacturing and physical properties of paints.

Fibre- Types, Constituents & their forensic importance.

Impression Evidence: Types of Impression Evidence, Significance of Impression Evidence. Tyre Marks Comparison. Skid marks, Serial numbers restoration.

Audio: Basics of sound, human ear and voice, Sound recording and reproduction, Forensic significance of voice.

Basic principles and techniques of black & white and colour photography; Camera and lenses, exposing, development & printing, different kinds of developers & fixers, modern developments in photography; Digital photography, Working of SLR & DSLR Cameras and basics of Digital Imaging Photography, photo-morphing, Crime Scene photography, Laboratory photography; Brief about speaker identification & tape authentication techniques and their applications in forensic science, Data Mining Techniques.

Videography: types of video cameras, recording of playback technique of analog video, recording and playback technique of analog video, basics of video codecs and file formats.

Restoration: Restoration of erased numbers, methods of marking-cast, punch and engraved, methods used for removal of serial numbers, theory behind number restoration, restoration of marks on cast iron, Aluminum, brass, wood, leather etc., chemical methods of restoration (etching), reagents used for various metals, electrolytic methods of restoration-reagents used, ultrasonic cavitation for restoration, magnetic particle method for restoration, other methods of restoration, laser etched serial numbers and bar codes and their restoration, recording of restored marks.

4) Essentials of Mathematics & Statistics In Forensic Physics

Number systems and their Representations, Units of measurement and their conversion, Dealing with Uncertainties in measurement. Types of Data, Basic concepts of frequency distribution, Measure of Central Values – Mean, Median and Mode, Measures of Dispersion, Range, Mean Deviation and Standard Deviation, Correlation and Regression Analysis.

Variance – Coefficient of variation, Moment, Coefficient of Regression, Correlated Measurements.

Probability Theory: Overview and Basic terms – Events, Trials, Mutually Exclusive events, Favorable Events, Exhaustive Events etc., Baye’s theorem, Addition and Multiplication theorem, Conditional Probability, Binomial Probability distribution, Normal Distribution, Hyper-geometric distribution, Applications – Matching of hair evidence, Uniqueness of Fingerprints,

Tests of Hypothesis – Test of Significance of attributes, sample test, t-test and comparison of datasets, Paired Test, Chi-Square test, F-test for equality of variance, Large sample test, Normal Test, Pearson’s χ^2 test. Discriminating Power and Evidence Significance: Derivation, Evaluation of evidence, Transfer of evidence – Likelihood Ratio, Probability of guilt, Correspondence probabilities, Weight of Evidence.

5) Forensic Voice Authentication

Physics of sound: waves and sound, analysis and synthesis of complex waves, Human and non-human utterances, anatomy of vocal tract, vocal formants, analysis of vocal sound, frequencies and overtones

Electronics of Audio Recording, Transmission and Playback devices, noise and distortion, voice storage and preservation

Forensic Linguistics: Phonetics, Morphology, Syntax, Semantics, Stylistics, Pragmatics, Script, orthography and graphology, Difference between language and speech, Psycholinguistics, Neurolinguistics, Sociolinguistics, Scientific approaches; Reliability and admissibility of evidence in the court, linguistic profile, language register

Discourse Analysis: Connivance, acceptance, listening feedback and rejection in the context of Mens-Rea, Narrative, Dialectology, Linguistic variety as a geographical marker, Idiolects and speaker characterization, Phonology, Morphology and Word formation processes as individual linguistic abilities

Various approaches in Forensic Speaker Identification, Instrumental Analysis of speech sample, Interpretation of result, Statistical interpretation of probability scale, Objective/Subjective methods, discriminating tests, closed test, open test, likelihood ratio calculation, Concept of test and error in Speaker Identification, case studies.

Techniques and Best Practices for examination of Audio recording authentication and case studies.

Automatic speaker identification and verification system based on fuzzy logics, neural network, MPCC etc., Voice Biometrics

VoIP and other modes of speech communication and their forensic analysis

6) Forensic Video Analysis

Introduction to video technology: electronic photography, scanning, synchronizing the analog signal, Digital signal processing, color video, Digital television standard, HD

Video, digital scopes, compression, image acquisition and recording formats, optical media, time code, audio for video, displays, Types of video Camera

Basics of CCTV, scope recognizing CCTV evidence & its nature, types of DVRs, DVR recording, evidence, best practices of CCTV evidence retrieval and storage at scene of crime and laboratory, challenges and precaution at the scene of crime, evidence handling procedure, legal issues, recommended equipments needed.

Watermarking, Interlacing, De-interlacing, Double Compression, Duplication, Re-projection

Forensic analysis: Best practices of collection, recovery, enhancement, analysis and interpretation of video evidence

Facial image recognition, vehicle registration plate image enhancement, foreign object detection, Authentication of Video evidence, video source identification techniques, Case studies

7) Criminalistics and Forensic Engineering

Soil: Physical examinations of soil evidence, Soil mechanics, Structure & Composition, Baking, Compaction and Agro-soil additives, Instrumental analysis of soil, Interpretation of soil evidence, Standard Operating Procedures for examination, Discussion on important case studies of soil evidence

Glass: Forensic examination of glass fractures, Physical and Microscopic examination of glass evidence, Standard Operating Procedures for examination, Discussion on important case studies of glass evidence

Paint: Types of paint and their composition, physical examination of paint, instrumental analysis of pigment, interpretation of paint evidence, Standard Operating Procedures for examination, Discussion on important case studies of paint evidence

Fibre: Classification and properties of textile, paper and fibres, Physical and Instrumental analysis of fibres evidence and dyes, Examination of damage to textiles, yarn, weaving & fabrics, Collection of fibre evidence, Interpretation of fibre evidence, Discussion on important case studies of fibre evidence

Cement: Cement and other constituents of Building materials and their properties, Identification of adulterated cement and adulterants, Sampling of evidence materials, Physical and chemical analysis of cement, cement mortar and cement concrete,

Methods of analysis of different constituents of Building materials, Steel bars and metal physics

Nano-science & Nano-technology: introduction to nanoparticles, nanotubes, utilization of nanotechnology in analysis of physical evidences, selectivity of nanoparticles with

compatibility and feasibility, Application of nanotechnology in forensic evidence analysis

Arson: Faults and failure of evidence of Arson & Fire due to electrical & mechanical faults/failure, Power Physics: Voltage, current generation and transmission, Current and Power Transformers, 3-phase electricity and Earth faults

8) Collision Investigation and Reconstruction

Road evidence, road engineering and design, Grit, Bitumen, soling and paving of cemented roads, identification and interpretation of road obstructions, defects, marks and damage, tyre marks, skid marks

Vehicle examination: Automobile common component and failure analysis, damage assessment, tyres – types speed and load rating, inflation and failures, brakes –types and brake systems, door lock and speed recording devices, safety restraint system – theory and examination of seat-belt child-seat and air-bag, vehicular fires

Speed analysis: vehicle and road kinematics, coefficient of friction and drag factor, methods of determining drag factor, influence on braking distance

Speed determination: skid marks measurement, speed from vehicle yaw, speed calculation on different road surfaces, falls, flips and vault speeds, special speed problem

Motorcycle accident investigation: types of motor cycle, dynamics rake and turning, acceleration and breaks, mechanical consideration and slide to stop speed determination

Hit and run investigation- examination of suspect vehicle, collection of evidence & control samples, inter-comparison of analytical result of physical evidence

Reconstruction of accident using Computer Aided Designing.

ii. Forensic Ballistics

a) Firearms and Ammunitions, their classification, details of various small arms used in crime – shotguns, rifles, revolvers, pistols, carbines, improvised firearms.

Bore and caliber, choke, automatic mechanisms employed in small arms, rifling – class characteristics of rifled bore, purpose of rifling, types of rifling, methods to produce rifling, various locks used in small arms. Head-space.

Various types of primers/ priming mixtures, propellants, shotgun ball ammunition, various kinds of bullets, head-stamp markings. Various physical, ballistic & functional tests of ammunitions.

b) Physical evidence and other clues Handling of evidence, various precautions.

- c) Internal Ballistics: Ignition and burning of propellants, degressive and progressive powders, rate of burning propellants, factors affecting internal ballistics of projectiles, internal ballistics of 12-bore guns, recoil.
- d) External Ballistics: Equations of motion of projectiles, principal problem of exterior ballistics, vacuum trajectory – calculation of various elements, effect of air resistance on trajectory, points of difference between trajectories in air and vacuum, nature of air resistance phenomena, base-drag, yaw, cross-wind force, overturning moments, stability – fin stabilization and gyroscopic stability, stability factor, nutation and precessional motions of bullets, drift, Magnus effect, Greenhill formula, shape of projectile – form factor, ballistic coefficient, calculation of trajectories of various small arm bullets, calculation of trajectories of shotgun projectile, use of ballistic tables, projectile velocity determination, determination of velocity of shot-charge, Doppler-radar method. Automated system of trajectory computation. Falling bullets – limiting velocity, drop, use of lead as bullet material.
- e) Terminal Ballistics: Interaction and penetration of various smallarm projectiles in various tissues. Threshold velocity for penetration of skin, flesh and bones, threshold energy/ casualty criteria, energy density, ricochet, various aspects of wound ballistics including wounds of entrance/ exit/ track of projectile, gunshot injuries caused by different types of firearm ammunitions. Temporary and permanent cavities, materials simulating human body, gunshot wound as a function of shape of nose of bullet, striking velocity, nature of target, tumbling of bullet, effect of instability of bullet, effect of intermediate target. Influence of range, identification of gunshot injuries, motion of projectile in dense medium.
- f) Class and Individual characteristics of fired bullets and cartridge cases and their linkage with the suspected firearms, comparison microscope, photomicrography, source correspondence, linkage of fired shots with shotguns.
- g) Determination of range of firing in cases of firing by smooth-bore and rifled firearms, factors affecting range of firing, stringing of shots, effect of string on pattern, Cart-wheel pattern, balling, Walkers' Test, IR photography.
- h) Chemical tests for examination and identification of shotgun holes in various targets. Gunshot residue. Identification of shooter.

Scientific methods of shooting reconstruction, suicide, murder, accident, self-defense and encounter cases. –medico-legal report, basic ballistic facts, laboratory examination reports, Documentation and evaluation of bullet holes in various materials, ricochet marks, pellet pattern in various targets

- i) Instrumentation techniques - AAS, NAA, SEM/EDXA, ICP-MS, ASV and their application in ballistic examination.
- j) Arms Act and Arms Rule, 2016.

ELECTIVE II: FORENSIC DOCUMENT EXAMINATION

- a) State-of-the-art-equipment: – Working & features of High Resolution Video Spectral Comparators and Electrostatic Detection Apparatus. Working & application of Stereo Zoom Microscope, Crossline Examination System, HPTLC and Raman Spectroscopy in document examination.
- b) Care, handling, preservation, packing, marking and forwarding of forensic documents. Analysis of paper & inks. Determination of sequence of intersecting strokes. Preliminary examination of documents. Comparison of alphabets and numerals. Examination of Document under various light sources.
- c) Document photography - Basic principles and techniques of black & white and colour photography. Specialized photography - UV, IR, transmitted light and side light photography close-up photography, trick photography, contact photography, Photomicrography & Microphotography. Demonstrative and juxtapose charts. Digital photography, file formats for digital photographs, digital watermarking and digital imaging. Photogrammetry & Radiography.
- d) Nature & scope of Forensic Document Examination and its limitations. Classification of forensic documents. Various writing features. Natural variations and disguise in hand writing Principle of handwriting identification. Procurement of standards for comparison. Comparison of like with like, suitability of standards for comparison. Effect of intrinsic & extrinsic factors on Handwriting.
- e) General and individual writing characteristics, definition and their estimation. Simon New Comb Theory of probability and its application in document

examination. Determination of absolute and relative age of documents. Examination of anonymous letter. Applications of Forensic Linguistics & Stylistics in Document Examination.

- f) Types of forgeries and their detection, characteristics of genuine & forged signatures. Difference between tremors of fraud and genuine tremors in writings and signatures. Identification of manipulations in written, typed and computer printouts, identification of digitally manipulated documents. Detection and decipherment of alterations including additions, over writings, obliterations, erasures and secret writings.
- g) Principle, working and identifying features of various printers, Various conventional printing processes- their identifying features. Examination of photo copies and scanned documents. Examination of genuine & counterfeit - Indian Bank Notes, MRTDs and Plastic Cards
- h) NABL guidelines for accreditation of Forensic Science laboratories. safety management in document laboratories
- i) Various Indian laws with reference to IPC –29, 29A, 34, 120B, 409, 415, 416, 418, 420, 467,468, 470, 471, 489(A to E), Indian Evidence Act – Sec 3, 45, 45A, 47, 73 and 114 . Final examination and report writing –different types of opinion writing and writing of reasons for opinion, importance of no opinion / qualified opinion. Debonair of expert and preparation for presentation of evidence in trial courts, examination-in-chief, cross examination by defense and cross examination by expert. Advances in Forensic Document Examination.

ELECTIVE III: DIGITAL FORENSICS

1) COMPUTER FORENSICS

- a) Introduction to Computer Hardware - Various Components of a Computer, Motherboard, Processor, Memory, Storage Devices and Networking components. Understanding Computer Operating Systems (OS), Booting process of computers. Introduction to File Systems and types of File System.
- b) Cyber Crime- Form of Cyber Crime, Internal and External Attacks, Crimes related to Social Media, ATM and Banking Frauds. Data Privacy issues, Packet sniffing, Spoofing, Web security.
- c) First responder – role and toolkit. Procedure for search and seizure of digital evidences. Search and Seizure of Volatile and Non-volatile Digital Evidence. Imaging and Hashing Digital Evidence. Analyzing and Recovery of Deleted, Hidden and Altered files.
- d) Windows Systems Artifacts: File Systems, Registry, Event logs, Shortcut files, Executables. Alternate Data Streams (ADS), Hidden files, Slack Space. Linux System and Artifacts: Linux file system: Ownership and Permissions, Hidden Files, User Accounts and Logs. Mac OS X systems and Artifacts: System Startup and Services, Network Configuration, Hidden Directories, System Logs and User Artifacts
- e) Web Browsers: Cookies, Favourites or Bookmarks, Cache, Session Data and Plugins. Email: Types of Email and Protocols. Analysing the Header details and tracking the email, Spoofed Mails. Virtual Machine and Cloud Technology Forensics.

2) NETWORK FORENSICS

- a) Computer Networking- Digital and Analog Signaling Methods, Network Types and Topologies, Overview of OSI Model and TCP/IP Protocol. Different types of IP Addresses and Classes, Subnet Masks, Subnetting and Supernetting. Network Hardware Devices and Client/Server Computing. Types of Networks – LAN, MAN and WAN. Routers and Routing Protocols.
- b) Network threats and vulnerabilities, Types of network attacks- eavesdropping, spoofing, modification, Cross-site scripting, DNS Spoofing, Routing Table

Poisoning, ARP Poisoning, Web Jacking. Attacks on Wireless Networks. Social Engineering Attacks and its types. Packet Sniffing, Types of authentication, Attacks on WEP, WPA and WPA-2 Encryption, fake hotspots.

- c) IP security architecture, Security protocols, IPSec, Web Security – Firewalls, IDS, IDPS. Network Security Applications, Authentication Mechanisms: Passwords, Cryptographic authentication protocol, Kerberos, X.509 LDAP Directory. Digital Signatures. Web Security: Secure Socket Layer (SSL) Encryption, Transport Layer Security (TLS), Secure Electronic Transaction (SET) and Virtual Private Networks (VPN).
- d) Monitoring of computer network and activities, Live Packet Capturing and Analysis. Searching and collection of evidences from the network. Network Intrusion Detection and Analysis. SQL Injection, Event Log analysis- tools and techniques. Investigating network attacks. Evidence collection from Routers other networking devices.
- e) Cloud Technology and its various components - private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Role of virtualization in enabling the cloud. Technologies and the processes required when deploying web services. Cloud Security Architecture, Secure Cloud based service, Identity and Access Management, Encryption and Key Management. Cloud Forensic – collection and analysis of evidence.

3) MOBILE AND WIRELESS DEVICE FORENSICS

- a) Introduction to Mobile Technologies - Asynchronous Transfer Mode (ATM), Wireless Application Protocol (WAP). Cellular technologies - Advanced Mobile Phone System (AMPS), i-Mode, Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and Global System for Mobile Communications (GSM) and relative strengths. Subscriber Identity Module (SIM), International Mobile Equipment Identity (IMEI).
- b) Functions of Bluetooth and security issues. Various Generation of Mobile Phone Technologies. Understanding of the mobile phone operating systems – Android, iOS, Windows. Understanding of SQLite Databases.
- c) Phone Phreaking, Call tampering, Wireless Hack Walkthrough and Man-in-the-Middle-attacks. Overview of WEP attack. Attacks on WEP, WPA and WPA-2

Encryption, fake hotspots. Wireless Public Key Infrastructure. Securing WLAN, WEP Decryption script.

- d) Overview of Mobile Forensics, Seizure and Preservation of mobile phones and PDA. Types of Evidence present in mobile phones - Files present in SIM card, external memory dump, and evidences in memory card. Mobile phone evidence extraction process, Data Acquisition Methods – Physical, File System, Logical and Manual Acquisition. Mobile Forensic Investigation Toolkit. Tracking of mobile phone location.

4) SOCIAL MEDIA FORENSICS AND CRYPTOGRAPHY

- a) Introduction to Social Media, Security Issues in Social Media, Types of crimes of Social Media – Cyberbullying, Online Grooming, Cyberstalking. Social Media and its impact on Business, Politics, Law and Revolutions, Emerging Trends in social media,
- b) Sources for social media evidence, Types of Data Available on Social Networking Sites, Different evidence collection methods from social networking sites, Intelligence gathering from Social Media- Tools and technique for intelligence gathering– indirect method, direct method with login, direct method without login.
- c) Introduction to Cryptography, Symmetric and Asymmetric Cryptosystem Encryption Techniques– Substitutional Cipher and Transpositional Ciphers. Types of keys – Public Key and Private Key. Advanced Encryption Techniques and Security Issues. Various types of attacks including Cipher Text-Only attack, Known-Plaintext Attack, Chosen-Plaintext Attack, Chosen-Cipher text Attack.
- d) Symmetric Cryptosystem – AES, DES, RC4, Blowfish. Asymmetric Cryptosystems – RSA, DSA, Elliptic Curve cryptography. Introduction to Cryptanalysis – Differential and Linear Cryptanalysis. Hashing Algorithms – MD5, SHA-1, SHA-2, SHA-3, One-Way Hash, Hash Message Authentication Code.

ELECTIVE IV: FORENSIC CHEMICAL SCIENCES

1) FORENSIC CHEMISTRY-I

- a) Alcohols and alcoholic beverages, Analysis of alcohols, country made liquor, illicit liquor and medicinal preparations, Analysis of various denaturants of alcohol, detection and determination of ethanol, methanol, aldehyde, ester by colour test and instrumental technique, Relevant sections of Excise Act.
- b) Metals and alloys their composition; Importance of analysis, purity of metals, trace elements, asht dhatu and their analysis
- c) Petroleum products and their adulterations: Analysis of petrol, kerosene, diesel, lubricants by BIS methods and ASTM methods. Detection of adulterants of gasoline, diesel and engine oils. Analysis of residues in forensic exhibits, chromatography analysis of petrol, kerosene, diesel and other solvents for detection of adulteration.
- d) Fire and Arson; Examination of crime scene, collection of exhibits, cause of fire and origin of fire, method of identification of inflammable material
- e) Analysis of trap case:- Mechanism of colour reaction, factor affecting the colour, detection of phenolphthalein and alkali used, method of detection of degraded product on conversion of pink colour to colourless solution by TLC and UV visible spectrophotometer. Photo and videography and voice recording as supporting evidence.
- f) Dyes: Role of dyes in crime investigation, comparison of dyes in fibres and different inks by TLC and UV-VIS Spectrophotometer.
- g) Pesticides: Different types of pesticide, formulation, identification of pesticide, standard or sub-standard or substituted pesticides. Determination of purity by analysis by chemical test, thin layer chromatography, ultra violet - visible spectrophotometry and gas liquid chromatography. Determination of level of pesticide in water, cold drinks, milk, food materials.

2) **FORENSIC CHEMISTRY-II**

- a) Explosive and Explosion: Introduction, classification of explosives- primary, secondary or High explosive, detonators pyro technique propellant IEDs and firing mechanism of IEDs
- b) Role of Forensic scientist in Post blast investigation, Explosion effects, Collection of samples, Technical report frame work, Home made crude bombs, Evaluation and assessment of explosion site and reconstruction of sequence of events.
- c) Analysis of explosive: Methods for extraction of explosive from post blast material/ debris, Qualitative analysis of explosives and explosion residue by colour test, TLC/HPTLC and High Performance Liquid Chromatography and FTIR, GC-Mass, LC-Mass. X ray diffraction, equipment used for detection of explosives and explosive devices.
- d) Narcotic Drugs and Psychotropic Substances: Sampling procedure and relevant notification, Laboratories authorised to conduct examination, an expert authorised to report NDPS cases.
- e) Laws related to forensic interest, Common terminology and NDPS act Small quantity and commercial quantity and extent of punishment
- f) Classification of Drugs commonly encountered: Narcotics, depressants, stimulants, hallucinogens designer drugs, club drugs and date rape drugs.
- g) Analysis of Drugs: Narcotic drugs, Depressants, Barbiturates, methaqualone, Benzodiazepines, Stimulants, Hallucinogens, Designer Drugs, Club drugs, date rape drugs and precursors by Field test kits for drugs and precursors using colour test, thin layer chromatography and further confirmation by HPTLC, UV-Vis spectrophotometry, Gas Chromatography, HPLC, GC-Mass Spectrometry and LC-Mass Spectrometry, Raman Spectroscopy and FTIR after extraction of drug from the seized sample.
Detection of common adulterants and determination of percentage purity in seized sample
- h) Court testimony and case studies.

3) **FORENSIC TOXICOLOGY - I**

- a) Forensic Toxicological examination and its significance. Branches of Toxicology: Introduction & Scope, Classification of poisons, based on their origin, mode of action, chemical nature, poisons and poisoning in India, Classification of poisoning: accidental, homicidal, suicidal and miscellaneous, sign and symptoms of poisons and antidotes. Factors affecting the intensity of poisoning. Importance of post-mortem examination in poisoning cases.

Information to be collected by Investigating Officers and precautions to be adopted while searching crime scene and collecting evidence material in poisoning cases. Laws related to Poisons. Poison Act 1919, Drugs Act 1940 and 1955, Drug and Cosmetic Act 1940 and amendments

- b) Classification of matrices- Biological, non-biological and Viscera. Different methods of extraction for volatile poisons of organic and inorganic nature: Solvent extraction, distillation /steam distillation, micro diffusion, dialysis, dry ashing, wet digestion, modified Stas-Otto method, ammonium sulphate method. Isolation and clean up procedure, separation of poisons and drugs using chromatographic techniques. Identification and estimation of poisons and drugs using chromatographic and spectrophotometric and other instrumental methods, significance of analytical studies with forensic examination.
- c) Analysis of different Gases and volatile poisons, Analysis of toxic metals and anions
- d) Analysis of pesticides: Organo chlorinated, organo phosphoro, carbamates, pyrethroids, aluminum phosphide and zinc phosphide
- e) Methods of analysis of acidic/ neutral and alkaline drugs and poison commonly encountered for forensic analysis
- f) Systematic method of extraction of poisons both organic and inorganic from biological matrix and their detection, identification and quantitation by colour test, TLC, HPLC, HPTLC, GLC, UV –visible spectrophotometry FTIR, Mass spectrometry. Qualitative and quantity analysis of Inorganic poisons using instrument AAS, ICP, ion chromatography, ion selective electrode.

4) FORENSIC TOXICOLOGY - II

- a) Modern method of extraction and Isolation: Solid phase extraction, solid phase micro-extraction, accelerated solvent extraction, preparative TLC and HPTLC
- b) Extraction of poisons from blood, urine, stomach wash and vomit, cold drink, food material, toxicological analysis of Nail, Bones and bile in decomposed materials. Interpretation of toxicological finding and preparation of reports, limitation of method and trouble shooting in toxicological analysis, disposal of analysis samples
- c) Hair analysis: Importance of hair for forensic examination of drugs and poisons, procedure for collection, storage and preservation. Methods of extraction of drugs and poisons from hair and their identification using instrumental techniques

- d) Metabolism: various path of metabolism of common poisons, their distribution and excretion and method of extraction, isolation and identification of metabolites.
- e) Food poisons: what is food poisoning, food poisoning due to common chemical and bacterial, sign and symptom of food poisoning, collection and preservation of evidence material, detection and identification by colour test and instrumental techniques
- f) Plant poison: introduction, classification and their main active constituents, method of extraction of plant material from biological sample, identification by colour test and TLC and UV- Visible spectrophotometer and other instrumental techniques
- g) Animal Poisons: Commonly encountered poisonous animals, snake and other insects, sign and symptoms, isolation of poison from biological material. Identity of poison by various chemical constituents, precipitant test and gel diffusion and immunological test
- h) Common poison used in animal poisoning including wild life animals
- i) Environmental pollutants- Inorganic and Inorganic and their identification and quantitation
- j) Quaternary ammonium drugs and poisons Introduction and problems associated with their extraction from pharmaceuticals and biological materials. Method of extraction using ion pair and identification by TLC and UV visible spectrophotometry and other instrumental techniques

5) INSTRUMENTAL TECHNIQUES - I

- a) Basic concept of atomic and molecular spectra.
- b) Basics of Instrumentation, sample preparation, purification of sample before analysis standardization and calibration of instrument
- c) Ultra violet and visible spectrophotometry: Basic principle and instrumentation, Lambert and Beers Law. Role in identification and quantitation in forensic chemistry and toxicology and its limitations. Fluorescence and phosphorescence and its application

- d) Infrared spectrophotometry: Basic principle, components, Sample handling, Dispersive and Fourier transform spectrophotometry, (FTIR). Qualitative analysis and interpretation of IR spectra, applications.
- e) Atomic Absorption Spectrometry (AAS): Instrumentation and techniques, interference in AAS, background correction methods, graphite furnace quantitative analysis. Applications in forensic chemistry and toxicology
- f) Atomic emission spectroscopy (AES)-Inductively Coupled Plasma and ICP-MS instrument for detection and quantitation of inorganic metals, alloys and poisons in biological materials. Advantage of ICP over AAS and vice –versa
- g) Chromatography Techniques; General principles of paper chromatography, column chromatography, TLC, gas chromatography, HPTLC and HPLC for identification and quantitation.
- h) X ray spectroscopy- X ray absorption and fluorescence their application in forensic chemistry and toxicology

6) INSTRUMENTAL TECHNIQUES - II

- a) Mass spectrometry: Basic principle and component of Instrument sample chamber, ionization method, mass analyser, vaccum system, data handling. Tandem mass spectrometry. Interpretation of spectra. Application in Forensic chemistry and forensic toxicology
- b) Raman spectroscopy Basic principle, sample handling Application in Forensic chemistry and toxicology. Advantage of Raman over IR/FTIR
- c) Nuclear Magnetic Resonance (NMR): basic principle and instrumentation, interpretation of spectra and application
- d) Measurement of radioactivity, carbon dating, Neutron Activation analysis and its application in forensic science
- e) Scanning Electron Microscope Coupled with EDXR, advantage of SEM over optical microscope. Application in Forensic Science

- f) Hyphenated techniques- Gas Chromatography coupled with Mass Spectrometry, Liquid chromatography coupled with Mass spectrometry, GLC- FTIR.

ELECTIVE V: FORENSIC PSYCHOLOGY

1. Psychology/ Forensic Psychology

- a. General/Cognitive Psychology
- b. Abnormal/ Clinical Psychology
- c. Industrial/ Organizational Psychology
- d. Social Psychology
- e. Biopsychology

2. Criminology

- a. Crime & Deviance
- b. Criminology
- c. Crime Prevention
- d. Schools of Criminology
- e. Criminal Justice System
- f. Criminal Law & Procedure
- g. Criminological Research & Statistical Applications
- h. Juvenile Delinquency
- i. Victimology

3. Aptitude in forensic Science

- a. Fundamentals of basic Sciences as applied to Forensic Investigation
- b. Quality Control and Quality Assurance in the analysis of evidence materials and Proficiency test
- c. Techniques and Instruments for Evidence analysis: Precision, accuracy, error rate and standardization
- d. Expert testimony in the Court of Law, Admissibility of Evidence
- e. Laws relevant to Forensic Science
- f. Ethics in Forensic Science

4. Reasoning

- a. Verbal and Non-Verbal Reasoning
- b. Analogies

- c. Similarities
- d. Relationship Concepts
- e. Arithmetical
- f. Visual Memory
- g. Discrimination
- h. Reasoning
- i. Differences
- j. Space Visualization
- k. Problem Solving
- l. Analysis
- m. Judgement
- n. Verbal and Figure Classification
- o. Number Series Observation
- p. Decision Making

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