# Department of Criminology & Forensic Science

## School of Applied Sciences


## Curriculum Framework

## of

## Master of Science

## Based on National Education Policy- 2020

**Date of BoS: September 17, 2022**

**Doctor Harisingh Gour Vishwavidyalaya**
**(A Central University)**
**Sagar-Madhya Pradesh-470003**

## About the Department

In 1950, UNESCO realized the significance of the teaching of criminal justice at the college and university levels in Asia, and in 1955, a consensus emerged at a symposium held in London. University of Saugor (Sagar) responded to that consensus first and as a result, the Department of Criminology & Forensic Science was established on 18th July 1959 largely due to the initiative taken by Shri D. P. Mishra, (the then Vice Chancellor, 1956-1962, and later Chief Minister of Madhya Pradesh). The former Chief Justice of the Madhya Pradesh High Court, Justice G. P. Bhatt, was appointed as its first regular Professor and Head of the Department.

The Department of Criminology and Forensic Science is running two different courses under the School of Applied Sciences. The department is involved in teaching Criminology and Forensic Science at the graduate and postgraduate levels, leading to B.A./M.A. in Criminology and B.Sc./M.Sc. in Forensic Science degrees, respectively, along with research facilities for Ph.D. in both the disciplines. The department is recognized as a DST-FIST-sponsored department. The contributions of the department are varied and remarkable in teaching and research. The alumni of the department are currently occupying outstanding positions and are globally known for their achievements.

## The Curriculum Framework based on the National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals to make the nation a self-reliant and global leader. In the same spirit, we at the Department of Criminology and Forensic Science have developed a curriculum framework to encompass the goals of NEP 2020. To this end, we have incorporated choice of subject/disciplines of study,creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points, as well as focusing on **experiential learning** for students by introducing **multidisciplinary and skill enhancement courses** and actual Hands on training in the recent and trending aspects of the area of concern.

### The Postgraduate Curriculum Framework for the Master of Science

1. **Name of the Programme :** M.Sc. Forensic Science
2. **About the Programme:**
   M.Sc. – Forensic Science is a 4 Semester (2 years) Post Graduate program providing knowledge and developing skills in the disciplines of Forensic Sciences. This PG program shall have a "Choice Based Credit System" (CBCS). There shall be a total of 4 Multi Disciplinary Major (MDM) of 4 credits each; 4 Multidisciplinary Major practical of 2 credits each. In addition there would be a total of 4 Discipline Specific Major (DSM) of 4 credits each; 4 Discipline Specific Major (DSM) practical of 2 credits each; There shall be 4 Skill enhancement courses (SEC) of 2 credits each in each semester respectively.
3. **Objectives of the Programme**
   After completion of course, the students will have a specialized and focused knowledge about:
   1. Principle, scope, ethics in Forensic Science.
   2. Physical evidence including forensic ballistics, medicine and jurisprudence.

3. General and emerging trends in forensic chemistry, forensic toxicology, forensic biology, questioned documents, etc., along with instrumental analyses.
4. Ideas about popular techniques, like different testing kits, DNA analysis, etc.

## 4. Programme Learning Outcomes :

The programme learning outcomes are attained by learners through the essential learning acquired on completion of selected courses of study within a programme. The outcomes and attributes described in qualification descriptors are attained by students through learning acquired on completion of a programme of study.

**a.** Organizational, hierarchical sets of FSL & CFSL, DSSB, and mobile forensic units.
**b.** Knowledge about civil and criminal cases and the court system with basic knowledge of fundamental rights, IPC, and IEA.
**c.** Learn about the search methods used in outdoor, indoor, and mobile crime scenes, their sketching methods, and their crime scene reconstruction methods.
**d.** Knowledge Of Forensic Biology, Forensic Medicines, Forensic Toxicology, Forensic Ballistics, Questioned Documents, and Emerging Trends and Techniques in Forensic Science.

## 5. Structure of the Programme

| Level: 8<br>Semester I | | | |
|---|---|---|---|
| **Nature of Course** | **Course Code** | **Course Title** | **Credits** |
| **Discipline Specific Major-1** | **FSC-DSM-121** | **Forensic Physics and Ballistics : Theory** | **04** |
| | **FSC-DSM-122** | **Forensic Physics And Ballistics: Practical** | **02** |
| **Discipline Specific Major-2** | **FSC-DSM-123** | **Instrumental Methods – Biological: Theory** | **04** |
| | **FSC-DSM-124** | **Instrumental Methods – Biological: Practical** | **02** |
| **Multi-Disciplinary Major-3** | **FSC-MDM-121** | **Forensic Science investigation and Criminal Justice System: Theory** | **04** |
| | **FSC-MDM-122** | **Crime scene investigation: Practical** | **02** |
| **Skill Enhancement Course (SEC)** | **FSC-SEC-121** | **Dactylography and Biometrics: Theory** | **03** |
| | **FSC-SEC-122** | **Dactylography and Biometrics: Practical** | **01** |

| Level: 8<br>Semester II | | | |
|---|---|---|---|
| **Nature of Course** | **Course Code** | **Course Title** | **Credits** |
| **Discipline Specific Major - 1** | **FSC-DSM-221** | **Instrumental Methods – Physical: Theory** | **04** |
| | **FSC-DSM-222** | **Instrumental Methods—Physical: Practical** | **02** |
| **Discipline Specific Major - 2** | **FSC-DSM-223** | **Instrumental Methods – Chemical: Theory** | **04** |
| | **FSC-DSM-224** | **Instrumental Methods – Chemical: Practical** | **02** |
| **Multi-Disciplinary Major - 3** | **FSC-MDM-221** | **Forensic Medicine and Medical Jurisprudence: Theory** | **04** |
| | **FSC-MDM-222** | **Forensic Medicine: Practical** | **02** |
| **Skill Enhancement Course (SEC)** | **FSC-SEC-223** | **Emerging Trends in Forensic Science: Theory** | **03** |
| | **FSC-SEC-224** | **Emerging Trends in Forensic Science: Practical** | **01** |

## 6. Exit: PG Diploma in Forensic Science

## 7. Teaching Learning Approach:

This programme will mainly transact the under given pedagogic approach-

- **a.** Lecture/ Seminar format
- **b.** Demonstration
- **c.** Readings/written assignments and field projects
- **d.** Group discussions/tutorial
- **e.** Community visit
- **f.** Project work
- **g.** Field Visit/Survey/Dissertation

## 8. Assessment

The learners in the programme will be assessed throughout the duration of the programme in formative and summative evaluations, i.e., mid (I & II) and end of semester examinations. To be eligible to appear in End semester examination a student must appear in Mid semester examinations along with 75 per cent attendance in classroom processes.

# SEMESTER I

| FSC-DSM-121 Forensic Physics and Forensic Ballistics : Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level Or Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem I | FSC-DSM- 121 | Forensic Physics and Forensic Ballistics : Theory | 4 | 0 | 0 | 4 | IA(Mid)-40<br>EA(End Sem)- 60 | |

## 1. Learning Objectives:

Forensic Physics is the application of physics for the examination of different physical evidence for courtroom purposes whereas forensic ballistics aims to impart specific knowledge of firearms and ammunition and their related phenomenon for solving shooting incidences.

## 2. Course Learning Outcomes :

Understanding firearms and their ammunition, Different fields of forensic ballistics which include Internal Ballistics, External and Terminal ballistics, Methods of investigation in shooting cases.

**Unit-I: Forensic Physics** **15 hrs**

Density, Refractive Index, Birefringence; Other Optical Properties of Crystalline Material. Examination of the Following- 1.Hair and Fiber 2. Soil 3. Dust 4. Paints 5. Glass 6. Glass Fracture 7. Tool Marks 8. Explosives Restoration of Erased / Obliterated Marks. Examination of Wire/ Cables, Counterfeit Coins. Physical Matching of Severed / Broken Objects. Speaker Identification and Tape Authentication: Voice Production Theory-Vocal Anatomy, Speech Signal Processing & Pattern Recognition- Basic Factors of Sound in Speech, Acoustic Characteristics of Speech Signal, Fourier Analysis, Frequency & Time Domain Representation of Speech Signal, Analogue to Digital Signal and Conversion, Fast Fourier Transform, Quantization, Digitization, and Speech Enhancement, Analysis of Audio-Video Signal for Authenticity, Introduction to the Techniques of Pattern Recognition and Comparison.

**Unit-II: Introduction to Ballistics** **15 hrs**

History and background, their classification and characteristics, Shotgun and rifled firearms (including pistols, revolvers and assault rifles), Various Components of Firearms: Barrel: chamber,leed, bore (calibre and its nomenclature Rifling, Purpose of Rifling, Types of Rifling), Action: its components and various types including manual, semiautomatic and automatic; Stock, Improvised/Country-Made/Imitative Firearms and their Constructional Features. Ammunition:, Classification and Constructional Features of Different Types of Cartridges, Types of Primers and Priming Composition, Propellants and their Compositions, Various Types of projectiles, Bullets and Compositional Aspects, Safety Aspects for Handling Firearms.

**Unit-III: Internal and External Ballistics** **10 hrs**

Definition, Ignition of Propellants, Shape and Size of Propellants, Manner of Burning, Various Factors affecting the Internal Ballistics,Theory of recoil, Exterior Ballistics, Vacuum Trajectory, Effect of external and internal factors on Trajectory of cylindro-conoidal bullets and shotgun projectiles, Ricochet bullets, maximum and effective range.

**Unit- IV: Terminal Ballistics (Wound Ballistics)** **10 hrs**

Concept of wound formation,Temporary and Permanent Cavities, Threshold Velocity for Penetration of Skin/Flesh/Bones, Effect of various types of projectiles on hitting the target, effect of various factors on wound formation: function of bullet shape, striking velocity, striking angle of intermediate target, tumbling of bullets, effect of instability of bullets, effect of intermediate targets, influence of range, yaw, stopping power.

Firearm Injuries: Nature of Wounds of Entry, Exit, and Initial Track with Various Ranges and Velocities with Evaluation of Injuries Caused by Shot-Gun, Rifle, Handguns, and Country Made Firearms, Post-Mortem and Antemortem Firearm Injuries.

**Unit- V: Identification of Firearms** **10 hrs**

Matching of crime and test: Principles and Practice of Identification of Firearms with fired projectiles in regular firearms and country made firearms.

Gun-shot residue: its formation and analysis (chemical and instrumental methods), Reconstruction of crime scene: Range of fire,Time of Fire, Different Method Employed and their Limitations.

## Essential Readings:


1. O'Hara C.E. & Osterburg, J.W. (1972). An Introduction to Criminalistics. Blomington, Indiana University Press.

2. Nickolls, L.C. (1956).Scientific Investigation of Crime. London, Bulterwest.

3. OrdogG.J. (1983). Management of Gunshot Wounds. USA, Elsevier.

4. Rose P. (2001). Forensic Speaker Identification:Forensic Science Series. London, Taylor and Francis.

5. Saferstein R. (1988). Forensic Science Handbook. NJ, Prentice Hall, Englewood Cliffs.

6. Sears F.W., Zemansky M.W., and YoungH. D. (1988). University Physics. California, Addition-Wesley Pub.

7. SellieretalK. G. (1994).Wound Ballistics and the Scientific Background. London, Elsevier.

8. Warlow T.A. (1996). Firearms: The Law and Forensic Ballistics. London, Taylor and Francis.

9. Working Procedures Manual: Ballistics. (2000) India, BPR & D Pub.

10. Sharma, B.R. (2002). Firearms in Criminal Investigation and Trials. Universal Law Publishing co. ltd.

**Suggested Reading**:

1. Bengold&Moryson N. (1999). Speech and Audio Signal Processing. USA, John Wiley & Sons.

2. Caddy B. (2001). Forensic Examination of Glass and Paint Analysis and Interpretation. UK, Taylor and Francis.

3. Hatcher, Jury, & Weller (1977). Firearms Investigation, Identification, and Evidence. Harrisburg, Stackpole Books.

4. Heard B.J. (1997). Handbook of firearms and ballistics. London, John Willey.

5. Hogg. V. (1982). The Cartridges Guide – A Small Arms Ammunition Identification Manual. Harrisburg, The Stackpole Co.

6. Jenkins and White, (2003). Fundamentals of Optics. USA, McGraw Hill.

7. Johari M. (1980). Identification of Firearms, Ammunition and Firearms Injuries. India, BPR&D.

8. Maio V.D. (1999). Gunshot Wounds. US, CRC Press.

9. Mathews, J.H. & Thomas, C.C. (1973). Firearms Identification, Vols. 1, 2, & 3. Illinois, Springfield.

10. Murray, R.C. & Tedrew J.C.F. (1991). Forensic Geology. New Jersey, Prentice hall.

| FSC-DSM-122 Forensic Physics and Forensic Ballistics : Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level / Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem I | FSC-DSM- 122 | Forensic Physics and Forensic Ballistics : Practical | 0 | 0 | 2 | 2 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To give practical knowledge about traces of evidence like dust, soil, glass, etc. and basic knowledge of techniques used to compare them.
2. **Course Learning Outcomes :**
   Understanding of the density gradient method for matching soil, glass, glass fractures and the refractive index of glass. chemical treatment of erased tool marks, lifting and casting of footmarks, tyre marks, handling of a comparison microscope.

**List of Practicals** **60 hrs**

1. Identification and Matching of Dust/ Soil Sample by Physical Method (Including Density Gradient Method).
2. Physical Matching of Cloth Sample and Identification of Glass Fractures.
3. Calculate the refractive index of glass with Abbe's Refractometer.
4. Restoration of an Erased Punched Mark on a Metal Piece by Chemical Treatment.
5. Lifting, Casting, and Evaluation of Tyre/Footwear Impressions Using Transo Scan Imaging.
6. Comparison of the Questioned Impression with Known ShoesUsing Transo Scan Imaging.
7. Comparison of Tool Marks and Fired Cartridge/ Bullet Using Comparison Microscope.
8. Identification of Shots and Pallets.

## Essential Readings:


1. O'Hara C.E. & Osterburg, J.W. (1972). An Introduction to Criminalistics. Blomington, Indiana University Press.

2. Nickolls, L.C. (1956).Scientific Investigation of Crime. London, Bulterwest.

3. OrdogG.J. (1983). Management of Gunshot Wounds. USA, Elsevier.

4. Rose P. (2001). Forensic Speaker Identification:Forensic Science Series. London, Taylor and Francis.

5. Saferstein R. (1988). Forensic Science Handbook. NJ, Prentice Hall, Englewood Cliffs.

6. Sears F.W., Zemansky M.W., and YoungH. D. (1988). University Physics. California, Addition-Wesley Pub.

7. SellieretalK. G. (1994).Wound Ballistics and the Scientific Background. London, Elsevier.

8. Warlow T.A. (1996). Firearms: The Law and Forensic Ballistics London, Taylor and Francis.

9. Working Procedures Manual: Ballistics. (2000) India, BPR & D Pub.

**Suggested Reading**:

1. Bengold&Moryson N. (1999). Speech and Audio Signal Processing. USA, John Wiley & Sons.

2. Caddy B. (2001). Forensic Examination of Glass and Paint Analysis and Interpretation. UK, Taylor and Francis.

3. Hatcher, Jury, & Weller. (1977). Firearms Investigation, Identification, and Evidence. Harrisburg, Stackpole Books.

4. Heard B.J. (1997). Handbook of Firearms and Ballistics. London, John Willey.

5. Hogg. V. (1982). The Cartridges Guide – A Small Arms Ammunition Identification Manual. Harrisburg, The Stackpole Co.

6. Jenkins and White, (2003). Fundamentals of Optics. USA, McGraw Hill.

7. Johari M. (1980). Identification of Firearms, Ammunition and Firearms Injuries. India, BPR&D.

8. Maio V.D. (1999). Gunshot Wounds. US, CRC Press.

9. Mathews, J.H. & Thomas, C.C. (1973). Firearms Identification, Vols. 1, 2 & 3. Illinois, Springfield.

10. Murray, R.C. &Tedrew J.C.F. (1991). Forensic Geology. New Jersey, Prentice hall.

| FSC-DSM-123 Instrumental Methods – Biological: Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level Or Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem I | FSC-DSM- 123 | Instrumental Methods in Biological: Theory | 4 | 0 | 0 | 4 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**

   To provide knowledge about biological/chemical analysis, centrifugation techniques, enzyme techniques, electrophoresis, immunochemical techniques, and molecular biology techniques.

2. **Course Learning Outcomes :**

   Understanding the basics of biological/ chemical analysis, pH and its measurement, Basic principles of sedimentation, types of centrifuges, enzyme kinetics, purification & protein estimation, enzyme assay techniques, immunochemical methods, gel electrophoresis and its working. 6. Outline of genetic manipulation enzyme, introduction to microfluidics.

**UNIT-I: General Principles of Biological/Chemical Analysis** **10 hrs**

Ionization Equilibrium in Acid and Base Aqueous Solutions, pH and its Measurement, Buffers, Physiological Solutions, Cell and Tissue Culture, Gene Cloning, Cell Disruption, Cell Fractionation, Biological Variation, etc.

**UNIT-II: Centrifugation Techniques and Flow Cytometry** **10 hrs**

Basic Principles of Sedimentation, Types of Centrifuges, Density Gradient Centrifugation, Prerogative Centrifugation, Analysis of Subcellular Fractions, Refrigerated & Ultra-Centrifuge.Flow Cytometry Principles and Applications.

**UNIT-III: Enzyme Techniques** **10 hrs**

Enzyme Kinetics, Purification and Protein Estimation, Enzyme Assay Techniques, Visible, UV Spectrophotometric Methods, Luminescence Methods, Radioisotope Methods, Immuno-Chemical Methods, Automated Enzyme Analysis, Immobilized Enzymes.

**UNIT-IV: Electrophoresis and Immunochemical Techniques** **15 hrs**

Gel Electrophoresis, Isoelectric Focusing etc. General Idea and Working of Gel Electrophoresis, PAGE, SDS-PAGE, Capillary Electrophoresis, Forensic Application of Electrophoresis. Production of Antibodies, Precipitation Reaction, Gel Immunodiffusion, Immune-Electrophoresis, Complement Fixation.

**UNIT-V: Molecular Biology Techniques, DNA Profiling and Microfluidics** **15 hrs**

Outline of Genetic Manipulation Enzymes, Enzymes in Genetic Manipulation, Cloning Procedures,

Isolation of Specific Nucleic Acid Sequences-Complementary DNA, Gene Libraries, Colony Hybridization, Nick Translation, Oligo-nucleotide Probes, Expression of Genes. DNA Profiling:Structure of DNA, Damage to DNA, Variation in DNA, DNA as an Excellent Polymorphic Marker, Basis of DNA Typing and Techniques: PCR, RFLP, etc. The Introduction of Microfluidics. Theory, Instrumentation, and its Applications.

## Essential Readings:


1. Li R. (2008). Forensic Biology: Identification and DNA Analysis of Biological Evidence. USA, Taylor & Francis.
2. McClintock J. T. (2014). Forensic Analysis of Biological Evidence, A Laboratory Guide for Serological and DNA Typing. NY, CRC Press.
3. Oates D.W., Brown, C.W., & Weigel, D.L. (1974). Blood and Tissue Identification of Selected Birds and Mammals. JPR study Projects Lincoln, NE, Nebraska Gome and Perks Commission. Philadelphia, Staff Research Publications.
4. Triggs C. M., Buckleton, J. S., & Walsh, S. J. (2004). Forensic DNA Evidence Interpretation. NY, CRC Press.
5. Walker J. M., and Rapley, R. (2009). Molecular Biology and Biotechnology. UK, Royal Society of Chemistry.
6. Williams, P. L., & Warwick, R. (1980). Gray's Anatomy, London, Churchill Livingston.


## Suggested Readings:


1. (1978). Biology Methods Manual. London: Metropolitan Police Forensic Science Laboratory.
2. Albert S., Bray B., Lewis D., Roberts K., and Watson J.D. (1989). Molecular Biology of Cell. New York,Garland Pub.
3. Clifford B.J.(1971). The examination and typing of bloodstains in the Crime Laboratory. USA, US Court Printing Press.
4. Edwin & Caney, H. M.(1993). Human Genetics: The Molecular Revolution. London, Jones & Bartlett Pub.
5. Epplen J. T., and Lubjumhin, T.(1995). DNA Profiling and DNA Fingerprinting. Basel, Birkhäuser Verlag. 6. Gardner E.J., Simmons M.I. & SnustadD.P.(1991). Principles of Genetics. New York, John Wiley.
7. Glover, D.M., & Hames, B.D.(1995). DNA Cloning, vol. 1 to 4. England, Oxford University Press, Oxford Pub.
8. Joshi A. R. (2002). A Textbook of Practical Biochemistry. India, B. Jain Publishers.

| FSC-DSM-124 Instrumental Methods—Biological: Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level Or Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem I | FSC-DSM-124 | Instrumental Methods Biological: Practical | 0 | 0 | 2 | 2 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To provide knowledge about the handling and working of instruments used for biological samples like Pcentrifugefuge, SEM, TEM, etc.
2. **Course Learning Outcomes :**
   Understanding of the working and handling of polymerase chain reaction instruments; protein estimation of biological samples; separation of cell organelles using centrifuge, Gel electrophoresis; SEM, TEM, UV spectrophotometer etc.

**List of Practicals** **60 hrs**

1. Demonstration of Handling and Working of PCR.
2. To Perform Protein Estimation of Given Biological Samples.
3. To Separate Cell Organelles in Given Tissues using Centrifuge.
4. Demonstration of Working and Handling of Gel Electrophoresis.
5. Demonstration of Working and Handling of Compound, Stereo Microscope, SEM and TEM.
6. Demonstration ofWorking and Handling of the UV-Spectrophotometer for the Examination of Biological Samples.

**Essential Readings:**

1. Li R. (2008). Forensic Biology: Identification and DNA Analysis of Biological Evidence. USA, Taylor & Francis.
2. McClintock J. T. (2014). Forensic Analysis of Biological Evidence, A Laboratory Guide for Serological and DNA Typing. NY, CRC Press.
3. Oates D.W., Brown, C.W., & Weigel, D.L. (1974). Blood and Tissue Identification of Selected Birds and Mammals. JPR study Projects Lincoln, NE, Nebraska Gome and Perks Commission. Philadelphia, Staff Research Publications.
4. Triggs C. M., Buckleton, J. S., & Walsh, S. J. (2004). Forensic DNA Evidence Interpretation. NY, CRC Press.
5. Walker J. M., and Rapley, R. (2009). Molecular Biology and Biotechnology. UK, Royal Society of Chemistry.

6. Williams, P. L., & Warwick, R. (1980). Gray's Anatomy. London, Churchill Livingston.

## Suggested Readings:

1. (1978). Biology Methods Manual. London: Metropolitan Police Forensic Science Laboratory.

2. Albert S., Bray B., Lewis D., Roberts K., and Watson J.D. (1989). Molecular Biology of the Cell. New York,Garland Pub.

3. Clifford B.J.(1971). The examination and typing of bloodstains in the Crime Laboratory. USA, US Court Printing Press.

4. Edwin & Caney, H. M.(1993). Human Genetics: The Molecular Revolution. London, Jones & Bartlett Pub.

5. Epplen J. T., and Lubjumhin, T.(1995). DNA Profiling and DNA Fingerprinting. Basel, Birkhäuser Verlag.

6. Gardner, E.J., Simmons M.I. & Snustad D.P.(1991). Principles of Genetics. New York, John Wiley.

7. Glover, D.M., & Hames, B.D.(1995). DNA Cloning, vol. 1 to 4. England, Oxford University Press, Oxford Pub.

8. Joshi A. R. (2002). A Textbook of Practical Biochemistry. India, B. Jain Publishers.

| FSC-MDM-121 Forensic Science Investigation and Criminal Justice System: Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level Or Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem I | FSC-MDM-121 | Forensic Science investigation and Criminal Justice System: Theory | 4 | 0 | 0 | 4 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives :**

   To provide knowledge about basic concepts of forensic science, crime, criminal theories, criminal investigation, management of crime scenes, and collection and packaging of different types of evidence and certain laws related to crimes in India.

2. **Course Learning Outcomes :**

   The fundamental principles and functions of forensic science and their significance to human society, the art of collecting, packaging, and preserving different types of physical and trace evidence at crime scenes, the importance of chain of custody, different types of crime scenes; various tools and techniques for analysis of different types of crime scene evidence and their processing in courts.

**Unit-I: Introduction to Forensic Science** **10 hrs**

Basic Principles and their Significance. The History and Development of Forensic Science, The Nature and Scope of Forensic Science. Organizational Structure of Forensic Science Laboratories at Central & State Level. Ethics in Forensic Science.

**Unit-II: Crime, Criminal Theories and Criminal Investigation** **15 hrs**

Definition, Theories of Causation of Crime: Pre-Classical and Neo-Classical, Constitutional, Geographical, Economic, Psychological, Sociological, MultipleCausation Approach. General Factors of Crime, Forms of Punishment in Brief, Radical Theory of Crime. Scene of Crime: Types,Protection of Scene of Crime, Crime Scene Documentation, Note Taking, Videography, Photography and Sketching Methods. Physical Evidence: Meaning, Types, Searching Methods, Collection and Preservation, Forwarding. chain of custody. Collection, Preservation, Packing and Forwarding of: Blood, Semen and Other Biological Stains, Firearm Exhibits, Documents, Fingerprint, Viscera, Hair & Fiber, Glass, Soil and Dust, Petroleum Products, Drugs and Poisons, etc. Investigation of the Following Crimes: Murder, Theft and House Breaking, Road Accident, Railways and Air Accidents, Arson, Sexual Assault Cases, Dowery Cases and Explosion Cases.

**Unit-III: Crime Scene Management and Reconstruction** **15 hrs**

Elements of Crime Scene Management- Information Management, Technology Management, Man-Power Management, and Logistic Management. An Introduction to Crime Scene Reconstruction, The Nature of Reconstruction, Physical Evidence and Reconstruction (Recognition, Identification, Individualization, and Reconstruction), Stages in Reconstruction, Types of Reconstruction, Pattern

Evidence in Reconstruction (Bloodstain Pattern Analysis for Reconstruction, Glass Fracture Patterns, Fire Burn Patterns, Tire and Skid Mark Patterns), Shooting Scenes, Requirements for Reconstruction after Crime Scene Released, Writing a Reconstruction Report.

**Unit-IV: IPC, CrPC and IEA** **10 hrs**

Indian Penal Code (1860): Introduction, General Exceptions, Offences against Person, Offences against Property, Attempt to Suicide, Sexual Offences. Criminal Procedure Code (1973): Introduction and General Idea of Sections:291- 93, 154, 155, 156, 157, 158, 159, 160, 161, 162, 172, 173, 174, 175, and 176. Indian Evidence Act (1872): Introduction and General Idea of Sections: 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, and 159.

**Unit-V: Criminal Justice System** **10 hrs**

Organization of Police in India,Organization of Courts in India, Jurisdiction of Courts in Criminal Cases, Prosecution, F.I.R., Case Diary, Interrogation of Suspects, Interview of Witness, and Procedure in Court as Per Criminal Procedure Code:- Summons Trial, Warrant Trial, and Summary Trial.

Report Writing and Evidence Evaluation: Report Formats of Crime Scene and Laboratory Findings. Court Testimony:Admissibility of Expert Testimony, Pre Court Preparation and Court Appearance, Examination in Chief; Re-Examination and Cross Examination.

## Essential Readings:


1. Peter R. D. F. (1983). Forensic Science-An Introduction to Criminalistics. USA, McGraw-Hill.

2. Saferstein, R. (1995). Criminalistics – An Introduction to Forensic Science. USA, Prentice Hall Inc.

3. Sharma, B.R. (2003). Forensic Science in Criminal Investigation and Trials. India, Universal Law Publishing Company.

4. Sharma, J.D. (1988). Vidhi vigyan. Avam Vish Vigyan. India, Hindi Granth Academy.

5. Sharma J.D. (2011). Apradhon ka Vigyanik Anveshan. India,Hindi Granth Academy.

6. Siegel J. A. &Kathy M. (2006). Forensic Science: The Basics. USA, CRC Press.

7. Unnithan N.P. (2013). Crime and Justice in India. India:SAGE Pub.


**Suggested Readings:**


1. Ahuja R. (2001). Criminology. India, Rawat Pub.

2. Aitken C.G.G. & Stoney, D.A. (1991). The Use of Statistics in Forensic Science. England,Ellis Harwood Limited.

3. Bowen R.T. (2016). Ethics and the Practice of Forensic Science. USA, CRC Press.

4. Burke R.H. (2013). An Introduction to Criminological Theory, 4th ed., UK, Routledge—Taylor & Francis Group.

5. Horswell J. (2016). The Practice of Crime Scene Investigation. USA, CRC Press.

6. Indian Penal Code, Criminal Procedure Code, Indian Evidence Act.

7. James, S.H., and Nordby, J.J. (2003). Forensic Science: An Introduction to Scientific and Investigative Techniques. USA, CRC Press.

8. James S.H. (2014). Forensic Science: An Introduction to Scientific and Investigative Techniques. UK,Taylor & Francis.

9. Nordby J. (1999). Dead Reckoning–The Art of Forensic Science Detection. USA, CRC Press.

10. O'Hara & Osterberg, (1949). An Introduction to Criminalistics. New York,The Macmillan Company.

| FSC-MDM-122 Crime Scene Investigation: Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level Or Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem I | FSC-MDM-122 | Crime Scene Investigation: Practical | 0 | 0 | 2 | 2 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To provide practical knowledge about demonstration, photography of the scene of crime, methods for searching for physical evidence, sketching and reconstruction of crime scenes.
2. **Course Learning Outcomes :**
   crime scene management and photography; different searching methods of crime scenes; different methods of crime scene sketching; collection, packing, labelling, and forwarding of physical evidence from the crime scene to the forensic science laboratory, methods of crime scene reconstruction.

**List of Practicals** **60 hrs**

1. Demonstration of Crime Scene Management.
2. Photography of Scene of Crime Digital Camera.
3. Methods for Searching for Physical Evidence at the Scene of Crime.
4. Sketching of an Outdoor Scene of Crime (Homicide or Suicide).
5. Sketching of an Outdoor Scene of Crime (Accident).
6. Sketching of Indoor Scene of Crime (Theft or Dacoity or Robbery).
7. Sketching of an Indoor Scene of Crime (Murder or Suicide).
8. Sketching of a Mobile Scene of Crime (Hit & Run Case).
9. Collection, Packing, Labeling and Forwarding of Physical Evidence from Scene of Crime to Forensic Science Laboratory.
10. Reconstruction of a Scene of Crime.

**Essential Readings**:

1. Peter R. D. F. (1983). Forensic Science-An Introduction to Criminalistics. USA, McGraw-Hill.
2. Saferstein, R. (1995). Criminalistics – An Introduction to Forensic Science. USA, Prentice Hall Inc.
3. Sharma, B.R. (2003). Forensic Science in Criminal Investigation and Trials India, Universal Law

publishing company.

4. Sharma, J.D. (1988). Vidhi vigyan. Avam Vish Vigyan. India, Hindi Granth Academy.

5. Sharma J.D. (2011). Apradhon ka Vigyanik Anveshan. India,Hindi Granth Academy.

6. Siegel J. A. &Kathy M. (2006). Forensic Science: The Basics. USA, CRC Press.

7. Unnithan N.P. (2013). Crime and Justice in India. India:SAGE Pub.

**Suggested Readings:**

1. Ahuja R. (2001). Criminology. India, Rawat Pub.

2. Aitken C.G.G. & Stoney, D.A. (1991). The Use of Statistics in Forensic Science. England,Ellis Harwood Limited.

3. Bowen R.T. (2016). Ethics and the Practice of Forensic Science. USA, CRC Press.

4. Burke R.H. (2013). An Introduction to Criminological Theory, 4th ed., UK, Routledge—Taylor & Francis Group.

5. Horswell J. (2016). The Practice of Crime Scene Investigation. USA, CRC Press.

6. Indian Penal Code, Criminal Procedure Code, Indian Evidence Act.

7. James, S.H., and Nordby, J.J. (2003). Forensic Science: An Introduction to Scientific and Investigative Techniques. USA, CRC Press.

8. James S.H. (2014). Forensic Science: An Introduction to Scientific and Investigative Techniques. UK,Taylor & Francis.

9. Nordby J. (1999). Dead Reckoning–The Art of Forensic Science Detection. USA, CRC Press.

10. O'Hara &Osterberg. (1949). An Introduction to Criminalistics. New York,The Macmillan Company.

| FSC-SEC-121 Dactylography and Biometrics: Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/ Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8/ Sem I | FSC-SEC-121 | Dactylography and Biometrics: Theory | 3 | 0 | 0 | 3 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**

   To provide knowledge about fingerprints, the development of fingerprints, biometrics, and face recognition.

2. **Course Learning Outcomes :**

   Understanding about The basics of fingerprint, history, patterns & classification, types of fingerprint, location, development, photography & comparison, ear biometrics and iris recognition, retina biometrics and face recognition.

**Unit-I: Introduction to Fingerprints** **8 hrs**

History of Fingerprints, Formation of Ridges, Different Fingerprint Patterns and Areas, Ridge Characteristics, Ridge Count, Ridge Tracing, Levels of Fingerprint Identification, Classification of Fingerprint- Henry system of classification, single digit classification, extension of the Henry system.

**Unit-II: Development of Fingerprints** **9 hrs**

Types of Fingerprint; Latent, Visible, and Plastic Prints, Location of Fingerprints; Development of Latent Prints by Physical and Chemical Methods. Photography and Comparison of Fingerprints, 3-D Development of Fingerprints

**Unit-III: Biometrics Part-1** **10 hrs**

Fingerprint Biometrics: Introduction to AFIS, Working of AFIS System, AFIS Components, Digitization & Processing of Fingerprints: Acquisition, Normalization & Segmentation, Enhancement, Binarization, Thinning & Post-processing, Minutiae Extraction, Fingerprint Matching in AFIS, Indexing & Retrieval. AMBIS- Integrated Biometric Identification System, CCTNS.

**Unit-IV: Biometrics Part-2** **10 hrs**

Iris Recognition: Introduction, Anatomical and Physiological Underpinnings; Iris Signature Representation and Matching; Localization, Representation; Matching.

Retina Biometrics: Structure of Eye; Human Retina and Structure; Unique Pattern of Blood Vessels; Retina Pattern and Identification.

Voice Production, Theory-Vocal Anatomy, Speech Signal Processing & Pattern Recognition- Basic Factors of Sound in Speech, Acoustic Characteristics of Speech Signal. An Introduction to the Techniques of Pattern Recognition and Comparison.

**Unit-V: Face Recognition and Facial Reconstruction** **8 hrs**

Face Recognition: Introduction, Detection, Representation, and Classification,Techniques and their Applications.

Facial reconstruction: 2D & 3D Facial reconstruction.

## Essential Readings:


1. Lee, H. C., & Ganesslen, R. E. (1991). Advances in Fingerprint Technology. CRC Press, London.

2. Malton D. (2009). Handbook of Fingerprint Recognition. Germany, Springer Science & Business Media.

3. Mehta M. K. (1989). Identification of Thumb Impression & Cross Examination of Fingerprints In India, N. M. Tripathi (P) Ltd.

4. Pierce, D. S. (2011). Mechanics of Impression Evidence. NY, CRC Press.

5. Stiefel C. (2011).Fingerprints: Dead People Do Tell Tales. NJ, Enslow Publishers.

6. Walker J. M., & Rapley, R. (2009). Molecular Biology and Biotechnology. UK, Royal Society of Chemistry.

7. Wilson C. (2011). Vein Pattern Recognition: A Privacy-Enhancing Biometrics. NY, CRC Press.

8. Stephen P. Kasper, Latent Processing Guide, Elsevier, UK, 2016.

9. Hilary Moses Daluz, Fundamentals of Forensic Analysis, CRC Press, 2015.


## Suggested Readings:


1. Albert S., Bray B., Lewis D., Roberts K., & Watson J.D. (1989). Molecular Biology of Cell. New York, Garland Pub.

2. Ashbaugh D. R., (1999). Quantitative and Qualitative Friction ridge analysis. NY, CRS Press.

3. Daluz H. M., (2014). Fundamentals of Fingerprint Analysis. NY, CRC Press.

4. Das R. (2014). Biometric Technology: Authentication, Bio Cryptography, and Cloud-Based

Architecture. India, CRC Press,

5. Edwin & Caney, H. M. (1993). Human Genetics: The Molecular Revolution. London: Jones &; Bartlett Pub.

6. Gardner E.J., Simmons M. I. & Snustad D.P.,(1991). Principles of Genetics. New York, John Wiley.

7. Jain A., Ross A.A.& Flynn P. (2008).Handbook of Biometrics. India,Springer Press.

8. Jain A., Ross A. A.& Nandakumar K., (2011). An Introduction to Biometrics. India, Springer Press.

| FSC-SEC-122 Dactylography and Biometrics: Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Level/ Semester** | **Course Code** | **Title of the Course** | **Credit** | | | | **Marks** | **Course Coordinator** |
| | | | **L** | **T** | **P** | **C** | | |
| **L8/ Sem I** | **FSC-SEC-122** | **Dactylography and Biometrics: Practical** | 0 | 0 | 1 | 1 | **IA(Mid)-40 EA(End Sem)- 60** | |

1. **Learning Objectives:**
   To provide practical knowledge about fingerprint collection methods, pattern identification, fingerprint development & lifting, lip print and examination.
2. **Course Learning Outcomes :**
   Understanding about The record fingerprint chart by direct print and rolling methods, identifying fingerprint pattern and ridge counting and tracing by TransoScan, development of latent prints and their lifting, identification of chances prints on different surfaces.

**List of Practicals** **30 hrs**

1. To Record a Fingerprint Chart by Direct Print Method and Rolling Method.
2. To Identify the Fingerprint Patterns along with Core and Delta.
3. To Perform Ridge Tracing and Ridge Counting of the Fingerprints.
4. Identification of Ridge Characteristics of Fingerprints by TrasoScan Lab Imaging System Method.
5. Development of Latent Prints by Powder Method and Chemical Methods on Porous and Non-Porous Surfaces.
6. Lifting of Fingerprints by Different Methods.
7. Identification of Chance Prints Found on Different Surfaces.
8. To Take Palm and Lip Prints and Their Examinations by TransoScan Lab Imaging System.

**Essential Readings:**

1. Lee, H. C., & Ganesslen, R. E. (1991). Advances in Fingerprint Technology. CRC Press, London.

2. Malton D. (2009).The Handbook of Fingerprint Recognition. Springer Science & Business Media, Germany.

3. Mehta M. K. (1989). Identification of Thumb Impression &; Cross Examination of FingerPrints.

India, N. M. Tripathi (P) Ltd.

4. Pierce D. S. (2011).Mechanics of Impression Evidence. NY, CRC Press.

5. Stiefel C. (2011).Fingerprints: Dead People Do Tell Tales. NJ, Enslow Publishers.

6. Walker J. M., and Rapley, R. (2009). Molecular Biology and Biotechnology. UK, Royal Society of Chemistry.

7. Wilson C. (2011). Vein Pattern Recognition: A Privacy-Enhancing Biometrics. NY, CRC Press.

**Suggested Readings:**

1. Albert S., Bray B., Lewis D, Roberts K., and Watson J.D. (1989). Molecular Biology of Cell. New York, Garland Pub.

2. Ashbaugh D. R., (1999). Quantitative and Qualitative Friction ridge analysis. NY, CRS Press.

3. Daluz H. M., (2014). Fundamentals of Fingerprint Analysis. NY, CRC Press.

4. Das R. (2014). Biometric Technology: Authentication, Bio Cryptography, and Cloud-Based Architecture. India, CRC Press.

5. Edwin & Caney, H. M. (1993). Human Genetics: The Molecular Revolution. London: Jones &; Bartlett Pub.

6. Gardner E.J., Simmons M. I. &;SnustadD.P.,(1991). Principles of Genetics. New York, John Wiley.

7. Jain A., Ross A.A.& Flynn P. (2008). The Handbook of Biometrics. India, Springer Press.

8. Jain A., Ross A. A. & Nandakumar K., (2011). An Introduction to Biometrics. India, Springer Press.

# SEMESTER II

| FSC-DSM-221 Instrumental Methods, Physical: Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/ Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-DSM-221 | Instrumental Methods Physical: Theory | 4 | 0 | 0 | 4 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To provide knowledge about the concept of analytical chemistry.
2. **Course Learning Outcomes :**
   Understanding about the handling and preparation of samples, qualitative and quantitative analysis of different analytes and matrix, basic principle and working of spectroscopic technique that could lead to professional job opportunities in testing laboratories the electrochemical methods, colorimetry, voltammetry which may facilitate small scale start-ups.

**Unit-I: Concepts of Instrumental Analytical Chemistry** **12 hrs**

Introduction to Analytical Chemistry, Analytical Approach (Defining the Problem, Designing the Analytical Chemistry, Sampling, Storage of Samples), Basic Statistics and Data Handling (Significant Figures, Accuracy and Precision, Types of Errors, Quantifying Random Error, Rejection of Results), Sample Preparation (Acid Dissolution &;Digestion, Fusions, Dry Ashing And Combustion, Extraction), Performing the Measurement (Signals and Noise, Plotting Calibration Curves), Assessing the Data (Limit of Detection, Limit of Quantification).

**Unit-II: Basic Concept of Spectroscopy** **12 hrs**

General Idea on Spectroscopy, The Electromagnetic Spectrum, Various Sources of Radiation, Their Utility and Limitations Interaction of Radiation with Matter, i.e., Reflection, Absorption, Fluorescence, Phosphorescence, Diffraction, Refraction, etc. Detection of Radiation, i.e., Photography, Photoelectric, etc. Optical Systems Used in Spectroscopy (Wavelength Selection Devices, Optical Slits, Detectors, Single- Beam and Double- Beam Optics), Dispersive Optical Layouts, and Fourier Transform Spectrometers. Forensic Applications of Spectroscopy.

**Unit-III: Basic Concept of Atomic and Molecular Spectra** **12 hrs**

Atomic Spectra- Energy Level, Quantum Number and Designation of States, Selection Rule. Molecular Spectra- Quantitative Discussion of Molecular Bindings, Molecular Orbital, Types of Molecular Energies, Discussion of Rotational, Vibrational, and Electronic Spectra. Ultraviolet-Visible and Infrared Spectrophotometry: Basic Principles, Instrumentation, Qualitative and Quantitative Analysis, Interpretation of Spectra, etc. Quantitative Analysis throughUltraviolet-Visible Spectroscopy,Forensic Application of UV-Vis. and IR Spectrophotometry.

**Unit-IV: Atomic Absorption/Emission and X-Ray Spectrometry** **12 hrs**

Basic Principles, Instrumentation, Qualitative and Quantitative Analysis, Interpretation of Spectra, and Forensic Applications. Radiochemical Techniques: Basic Principles and Theory, Introduction about Nuclear Reactions and Radiations, Neutron Activation Analysis (NAA), Nuclear Magnetic Resonance Spectroscopy (NMR), Application of Radiochemical Techniques in Forensic Science.

**Unit-V: Electroanalytical Chemistry** **12 hrs**

Fundamentals of Electrochemistry, Electrochemical Cells (Line Notation for Cells and Half Cells, Standard Reduction Potentials, Sign Conventions, The Nernst Equation, Activity Series, Reference Electrodes, the Electrical Double Layer), and Electroanalytical Methods (Potentiometry, Colorimetry, Conductometric Analysis, Polarography, Voltammetry).

## Essential Readings:


1. Sharma B.K., (2000). Instrumental Methods of Chemical Analysis. India, Krishna Prakashan Media.
2. Silverstein R.M. &; Webster F.X., (1997). Spectrometric Identification of Organic Compounds. USA, John Wiley &; Sons, Inc.
3. Skoog D.A., Holler F.J. &;Stanley R.C. (2017). Principles of Instrumental Analysis, USA,Cengage Learning.
4. Subrahamanyam N. &;BrijLal (2004). A TextBook of Optics. India, S. Chand &; Co.
5. Thompson K.C. & Renolds R.J. (1978). Atomic Absorption Fluorescence &; Flame Emission Spectroscopy: Practical Approach. London, Charles Griffin &; Co.
6. Willard H. &; Lynne L.M. (1986).Instrumental Methods of Analysis. USA, CBS Publishers &; Distributors.
7. Willard H.H., Merrett L. L. Frank J.A.D. &; Settle A. (1986). Instrumental Methods of Analysis. USA, CBS Pub. &; Distributors.


## Suggested Readings:


1. Chatwal and Anand. (2016). Instrumental Methods of Chemical Analysis. India, Himalaya Publishing House Pvt. Ltd.
2. Churáček J. (1993). Advanced Instrumental Methods of Chemical Analysis. Michigan, E. Harwood,
3. Dean J. A. (1995). Analytical Chemistry Handbook. USA, McGraw Hill Inc.
4. Kalri P.S. (2001). Spectroscopy of Organic Compounds. India, New Age International Pub.
5. Khandpur R.S. (2004).Handbook of Analytical Instruments. USA, Tata McGraw Hill Pub. Co.
6. Khanna D.R. &;Gulati H.R. (2002). Fundamentals of Optics Geometrical Physical &; Quantum. India, R. Chand &; Co.
7. Patania V.B. (2004). Spectroscopy. India, Campus Books International.
8. Robinson J.W. (1996). Atomic Spectroscopy, Revised &; Expanded. NY, Marcel Dekkar, Inc.

| FSC-DSM-222 Instrumental Methods Physical: Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level Or Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-DSM-222 | Instrumental Methods Physical: Practical | 0 | 0 | 2 | 2 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To provide practical knowledge about the concept of analytical chemistry.
2. **Course Learning Outcomes :**
   Understanding of different sample preparation techniques, qualitative and quantitative analysis of different analytes, handling and operation of UV spectroscopy, handling and operating of FTIR spectroscopy, working of other spectroscopic techniques.

**List of Practicals** **60 hrs**

1. To Understand the Working and Measurement of λ Max of Various Organic Compounds by UV-Vis. Spectrophotometer.
2. To Know the Concentration of Given Liquid by Colorimeter.
3. Sample Preparation and FTIR Analysis of Drugs of Abuse.
4. To Measure the pH of Different Substance using pH Meter.
5. To Know the Practical Working and Handling of Comparison Microscope.
6. To Know the Practical Working and Handling of Stereo Microscope.

## Essential Readings:


1. Sharma B.K., (2000). Instrumental Methods of Chemical Analysis. India, Krishna Prakashan Media.
2. Silverstein, R.M., & Webster, F.X. (1997). Spectrometric Identification of Organic Compounds. USA, John Wiley & Sons, Inc.
3. Skoog D.A., Holler, F.J., and Stanley, R.C. (2017). Principles of Instrumental Analysis, USA,Cengage Learning.
4. Subrahamanyam N. &;BrijLal (2004). A Textbook of Optics. India, S. Chand &; Co.
5. Thompson, K.C., & Renolds, R.J. (1978). Atomic Absorption Fluorescence &; Flame Emission Spectroscopy: Practical Approach. London, Charles Griffin & Co.
6. Willard H. & Lynne L.M. (1986). Instrumental Methods of Analysis. USA, CBS Publishers &; Distributors.
7. Willard H.H., Merrett L.L., Frank J.A.D., and Settle A. (1986). Instrumental Methods of Analysis. USA, CBS Pub. & Distributors.

**Suggested Readings:**

1. Chatwal and Anand. (2016). Instrumental Methods of Chemical Analysis. India, Himalaya Publishing House Pvt. Ltd.

2. Churáček J. (1993). Advanced Instrumental Methods of Chemical Analysis. Michigan, E. Harwood,

3. Dean J. A. (1995). Analytical Chemistry Handbook. USA, McGraw Hill Inc.

4. Kalri, P.S. (2001). Spectroscopy of Organic Compounds. India, New Age International Pub.

5. Khandpur R.S. (2004).Handbook of Analytical Instruments. USA, Tata McGraw Hill Pub. Co.

6. Khanna D.R. &;Gulati H.R. (2002). Fundamentals of Optics Geometrical, Physical, and Quantum. India, R. Chand & Co.

7. Patania V.B. (2004). Spectroscopy. India, Campus Books International.

8. Robinson, J. W. (1996). Atomic Spectroscopy, Revised and Expanded. NY, Marcel Dekkar, Inc.

| FSC-DSM-223 Instrumental Methods Chemical: Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-DSM-223 | Instrumental Methods Chemical: Theory | 4 | 0 | 0 | 4 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To provide knowledge about the basic concept of separation and sample extraction from various matrices.
2. **Course Learning Outcomes :**
   Understanding about The sample handling and solvent extraction techniques the basic principle and working of chromatographic technique that could lead to professional job opportunities in testing and pharmaceutical laboratories, the basic principle and working of mass spectroscopy, electrophoresis technique and centrifugation methods

**Unit-I: Relating Chromatography to Separations** **15 hrs**

Definition of Separation, Origin of Chromatography (Definition of Chromatography, Similarity of Chromatography to Separation Methods, Separation in Nature) Principal of Separations, Modes of Chromatography, Unified Separation Science, Selectivity and Detectability. Simple Separation Methods-Evaporation, Precipitation, Crystallization, Filtration, Membrane Separation. General Idea and Basic Principle of Distillation, Various Types of Distillation Techniques,
Distribution Law, Solvent Extraction Techniques like LLE, SPE, SPME.

**Unit-II: Sample Handling and the Chromatography** **15 hrs**

Introduction, Sample Collection Procedures (Sampling of Solid, Liquid & Gas), Sample Preparation, Recovery Procedures (Solvent Extraction, Supercritical Fluid Extraction, Volatilization Processes), Sample Cleanup Methods (Membrane Techniques, Chromatography, Solid Phase Extraction, Chemical Modification of the Sample by Pre- Column Reaction), Pre-Concentration Techniques, Contamination Effects. Introduction and Overview of Chromatography- and Historical Aspect of Chromatography, Classification of Chromatography (Mobile Phase Mode, Technique, Development Mode, Separation Mechanism &; other Systems of Classification), Comparison of Chromatographic Techniques.

**Unit-III: Theory of Chromatography** **10 hrs**

Introduction Chromatographic Retention (Parameters for Column and Planar Techniques), Peak Shape, Zone Broadening, and Measures of Efficiency (Plate Theory, Rate Theory, Van Deemter Plot, Extra Column Effects in Zone Broadening, other Measures of Separation optimizing Resolution, and Overall Systems Performance). General Principles and Working of Planer Chromatography: TLC, HPTLC, Forensic Application of Planar Chromatography, Brief Idea on Working of HPLC, GC, Ion Exchange Chromatography, Exclusion (Permeation) Chromatography, Affinity Chromatography etc. Forensic Application of Column Chromatography.

**Unit-IV: Electrophoretic Techniques** **10 hrs**

General Principles, Classification of Electrophoresis, Factors Affecting Electrophoresis, Preparative, Horizontal, Vertical, Two Dimensional Electrophoresis A Brief Idea of Low Voltage Electrophoresis, High Voltage Electrophoresis, Gel Electrophoresis, Isoelectric Focusing, etc. General Idea And Working of Capillary Electrophoresis, Forensic Application of Electrophoresis.

**Unit-V: Mass Spectrometry** **10 hrs**

Principle and Instrumentation, Correlation of MS with Molecular Structure. A Brief Idea About the Various Forms of Mass Spectrometry Coupling MS with GC, LC, and CE etc. Application of MS in Forensic Science.

## Essential Readings:


1. Sharma B.K. (2000).Instrumental Methods of chemical Analysis.India, KrishnaPrakashan Media.
2. Shrivastava & Shrivastava (1991). Introduction to Chromatography. India, S.Chand& Co.
3. Smith and Bogusz M. (2007).Handbook of Analytical Separation.Germany,Elsevier Pub.
4. Srivastava M. (2010). High-Performance Thin-Layer Chromatography (HPTLC). Germany,Springer Science &; Business Media.
5. Stahl E. (2013). Thin Layer Chromatography. Germany, Springer Science &;Business Media.
6. Triggs C.M.Buckleton J.S. &;Walsh S.J. (2004).Forensic DNA EvidenceInterpretation. CRC Press, USA
7. Walker, J.M., and Rapley, R.(2009). Molecular Biology and Biotechnology. UK,Royal Society of Chemistry.
8. Willard, Merrit and Dean. (1974). Instrumental Methods of Analysis. USA, Van Nostrand.


## Suggested Readings:


1. Chapman J.R. (1993). Practical Organic Mass spectrometry, A Guide for Chemical and Biochemical Analysis. New York, Wiley Pub.
2. Chatwal and Anand. (2016). Instrumental Methods of Chemical Analysis. India, Himalaya Publishing House Pvt. Ltd.
3. Harris H., Gaensslen R., and Lee H. (2007). An Introduction to Forensic Science. USA, McGraw -Hill Education
4. Jarris K.E., Gray A.L., and Hock R.S. (1992). EDS; handbook of Inductively Coupled Plasma Mass Spectrometry; Glasgow, Blockie Pub.
5. Lindsay, S. (1992). High Performance Liquid Chromatography. New York: Wiley Pub.
6. Maclaffrty, F.W., and Turecek, F. (1993). Interpretation of mass spectra. US, Mill Valley, C A Univ. Science Books.
7. Robards K. Jackson P.E. &; Haddad P.A. (2012). Principles and Practice of Modern Chromatographic Methods. Germany, Elsevier pub.
8. Saferstein R. (2001). Forensic Science Handbook Vol. I. London, Prentice Hall.

| FSC-DSM-224 Instrumental Methods, Chemical: Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-DSM-224 | Instrumental Methods Chemical: Practical | 0 | 0 | 2 | 2 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To provide practical knowledge about the basic concept of separation and extraction of drugs and pesticides from various matrices.
2. **Course Learning Outcomes :**
   Understanding the TLC method for plant alkaloid analysis and identification, dye identification using TLC methods, pesticide substance analysis in forensic exhibits, and the use and handling of chromatographic techniques.

**List of Practicals** **60 hrs**

1. To Separate & Identify the Plant Pigments using Paper Chromatography.

2. To Identify the Dyes Present in Petroleum Products Using Thin Layer Chromatography.

3. To Know the Practical Working and Handling of High Performance Liquid Chromatography by Analyzing Depressant Drugs.

4. To Know the Practical Working and Handling of High Performance Thin Layer Chromatography by Analyzing the Ink Samples.

5. To Know Practical Working and Handling of Gas Chromatography by Analyzing Volatile Poisons.

6. To Know Practical Working and Handling of Low Voltage and High Voltage Electrophoresis by analyzing the Amino Acids &; other Biochemical Samples.

## Essential Readings:


1. Sharma B.K.(2000).Instrumental Methods of chemical Analysis.India, KrishnaPrakashan Media.
2. Shrivastava & Shrivastava(1991). Introduction to Chromatography. India, S.Chand& Co.
3. Smith and Bogusz M. (2007).Handbook of Analytical Separation.Germany,Elsevier Pub.
4. Srivastava M. (2010). High-Performance Thin-Layer Chromatography (HPTLC). Germany,Springer Science &; Business Media.
5. Stahl E. (2013). Thin Layer Chromatography. Germany, Springer Science &;Business Media.
6. TriggsC.M.Buckleton J.S. &;Walsh S.J. (2004).Forensic DNA EvidenceInterpretation. CRC Press, USA
7. Walker, J.M., and Rapley, R.(2009). Molecular Biology and Biotechnology. UK,Royal Society of Chemistry.

8. Willard, Merrit and Dean. (1974). Instrumental Methods of Analysis. USA, Van Nostrand.

## Suggested Readings:

1. Chapman J.R. (1993). Practical Organic Mass spectrometry, A Guide for Chemical and Biochemical Analysis. New York, Wiley Pub.

2. Chatwal and Anand. (2016). Instrumental Methods of Chemical Analysis. India, Himalaya Publishing House Pvt. Ltd.

3. Harris H., Gaensslen R., and Lee H. (2007). An Introduction to Forensic Science. USA, McGraw -Hill Education

4. Jarris K.E., Gray A.L., and Hock R.S. (1992). EDS; handbook of Inductively Coupled Plasma Mass Spectrometry; Glasgow, Blockie Pub.

5. Lindsay, S. (1992). High Performance Liquid Chromatography. New York: Wiley Pub.

6. Maclaffrty, F.W., and Turecek, F. (1993). Interpretation of mass spectra. US, Mill Valley, CA, Univ. Science Books.

7. Robards K. Jackson P.E. &; Haddad P.A. (2012). Principles and Practice of Modern Chromatographic Methods. Germany, Elsevier pub.

8. Saferstein R. (2001). Forensic Science Handbook Vol. I. London, Prentice Hall.

| FSC-MDM-221 :Forensic Medicine and Medical Jurisprudence: Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-MDM-221 | Forensic Medicine and Medical Jurisprudence: Theory | 4 | 0 | 0 | 4 | IA(Mid)- 40<br>EA(End Sem)- 60 | |

1. **Learning Objectives:**

   To provide knowledge about forensic medicine and the concepts of medical jurisprudence, personal identification, thanatology, autopsy, post mortem examination, examination of injuries, and the importance of forensic anthropology and forensic odontology in forensic science.

2. **Course Learning Outcomes :**

   Understanding the importance of personal identification in mass disaster cases, importance of autopsy, knowledge on different types of injury and wound, the different techniques of facial reconstruction and their forensic importance, importance of forensic odontology.

**Unit-I: Forensic Medicine and Concept of Medical Jurisprudence** **12 hrs**

Definition, Developmental History, Brief knowledge about legal procedures in courts, inquests, criminal courts and their powers, subpoenas, and oaths of medical experts. Recording of Medical Experts' Evidence in Courts. Types of Medical Evidence,Kinds of Witness, and Rules for Giving Evidence.

**Unit-II: Personal Identification** **12 hrs**

Definition and Importance of Personal Identification. Parameters Contributing to Personal Identity-Race, Sex, Age, Complexion, Features &Photographs, Anthropometry, Fingerprints, Footprints, Tattoo Marks, Lip Prints, Ear Prints, Brain Fingerprinting, Scars, Occupational Marks, Handwriting, Personal Belongings, Voice &Speech, DNA, Superimposition Techniques for Skull and Trace Evidence Factors. Disputed Paternity.

**Unit-III: Thanatology, Autopsy and Post-Mortem Examination** **12 hrs**

Thanatology: Definition, Meaning, Death, Type of Death, Concept of Death, Modes of Death and their Causes and Sign (Immediate Changes, Early Changes, Late Changes) and Symptoms, Manner of Death, Cause of Death, Asphyxial Death, Suspended Animation and Medico LegalImportance of Death. Autopsy: Definition, Classification, Concepts, Objectives, Legal Formalities for Autopsy, Autopsy Procedure, Skin Incisions, etc. Post-Mortem Examination: Importance, Post-Mortem Report Format, External & Internal Examination in Brief. Viscera & Its Preservation. Examination of Asphyxial Death, Examination of Decomposed and Mutilated Bodies. Precautions to be taken during Post Mortem Examination.

**Unit-IV: Injuries** **12 hrs**

Definition, classification, Mechanical Injuries (Abrasion, Contusion, Laceration, Fracture and Dislocation of Bone/ Teeth, Incised Wounds, Chop Wound, Stab Wounds and Firearm Wounds), Regional Injuries, Thermal Injuries (Injuries due to Cold and Heat), Chemical Injuries, Miscellaneous Injuries.Medico-Legal Aspects, Post Mortem & Ante Mortem Wounds, General Characteristics of Injuries from Burns, Scalds, Lightning, Electricity and Radiation.

**Unit-V: Forensic Odontology and Anthropology** **12 hrs**

Dentition Pattern, Types and Structure of Teeth, Age Determination- Identity of Person, Role in Mass Disaster, Disease of Teeth and their Significance in Personal Identification. Identification of Burnt Bones, Recovery and Identification of Skeletal Remains in Accident Cases and Mass Disasters, Facial Reconstruction.

## Essential Readings:


1. Parikh C.K. (1972).Forensic Medicine and Toxicology. India,Medical Publications.
2. Polson C.J., Gee, D.J., and Knight, B. (1985). The Essentials of Forensic Medicine. France,Pergamon Press.
3. Simpsen K. & Knight B. (1996). Forensic Medicine 11th edit. USA,Taylor & Francis.
4. Taylor A. S. (1853). Medical jurisprudence. Philadelphia,Blanchard & Lea.
5. Thompson T., Black S. (2006).Forensic Human Identification: An Introduction. NY,CRC Press.
6. Vij K. (2014). Forensic Medicine & Toxicology: Principles & Practice. India, Elsevier Health Sciences.


## Suggested Readings:


1. Adelman H. C. (2007). Forensic Medicine, NY,Infobase Publishing.
2. Aggrawal A. (2016). Textbook of Forensic Medicine and Toxicology. Avichal Publishing Company.
3. Catanese C. A. (2009). Color Atlas of Forensic Medicine and Pathology. NY, CRC Press.
4. Deoskar A. S., Tank A. H. (2010). Medical Jurisprudence, Toxicology and Forensic Science for Class Room, Investigation and Court Room with Case Laws, 3rd Ed. India, All India Refreshers.
5. Jason P. J., and Busuttil, A. (2003). Forensic Medicine: Clinical and Pathological Aspects. Cambridge University Press, England.
6. Jason P. J. & Simpson K. (2014).Simpson's Forensic Medicine, NY, CRC Press.
7. Mallet X. (2014). Advances in Forensic Human Identification. NY, CRC Press.
8. Modi J.S. (2011). Medical Jurisprudence and Toxicology, India, Law Publishers.
9. Molina D. K., & M.D. (2009). Handbook of Forensic Toxicology for Medical Examiners. USA,CRC Press.

| FSC-MDM-222: Forensic Medicine: Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/ Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-MDM-222 | Forensic Medicine: Practical | 0 | 0 | 2 | 2 | IA(Mid)- 40<br>EA(End Sem)- 60 | |

1. **Learning Objectives:**

   To provide practical knowledge about bones of human body, age & sex of a person, bite marks, insects, pollen grains, diatoms, race & species and lip prints.

2. **Course Learning Outcomes :**

   Understanding aboutIdentification of bones for human and animal origin, determination of age and sex of a person from long bones and skull, casting and photography of bite marks, collection and identification of pollen grains and diatoms, race and species determination by blood grouping methods etc.

**List of Practicals** **60 hrs**

1. Draw and label the bones of the human body.
2. Determination of Age and Sex of a Person from Long Bones.
3. Determination of Age and Sex of a Person from Skull.
4. Recording of Bite Marks by Casting& their Photography.
5. Collection and Identification of Important Insects for Forensic Studies.
6. Collection and Identification of Pollen Grains, Diatoms of Forensic Importance.
7. Determination of Race and Species by Blood Grouping Methods.
8. Examination of Lip Prints.

**Essential Readings:**

1. Parikh C.K. (1972).Forensic Medicine and Toxicology. India,Medical Publications.
2. Polson C.J., Gee D.J. & Knight B. (1985). The Essentials of Forensic Medicine. France,Pergamon Press.
3. Simpsen K. & Knight B. (1996). Forensic Medicine 11th edit. USA,Taylor & Francis.
4. Taylor A. S. (1853). Medical jurisprudence. Philadelphia,Blanchard & Lea.
5. Thompson T., Black S. (2006).Forensic Human Identification: An Introduction. NY,CRC Press.
6. Vij K. (2014). Textbook of Forensic Medicine & Toxicology: Principles & Practice. India, Elsevier Health Sciences.

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1. Adelman H. C. (2007). Forensic Medicine, NY,Infobase Publishing.

2. Aggrawal A. (2016). Textbook of Forensic Medicine and Toxicology. India,Avichal Publishing Company.

3. Catanese C. A. (2009). Color Atlas of Forensic Medicine and Pathology. NY, CRC Press.

4. Deoskar A. S., Tank A. H. (2010). Medical Jurisprudence, Toxicology and Forensic Science for Class Room, Investigation and Court Room with Case Laws, 3rd Ed. India, All India Refreshers.

5. Jason P. J. &Busuttil A. (2003). Forensic Medicine: Clinical and Pathological Aspects. England,Cambridge University Press.

6. Jason P. J. & Simpson K. (2014).Simpson's Forensic Medicine, NY, CRC Press.

7. Mallet X. (2014). Advances in Forensic Human Identification. NY, CRC Press.

8. Modi J.S. (2011). Medical Jurisprudence and Toxicology.India, Law Publishers.

9. Molina D. K.& M.D. (2009).Handbook of Forensic Toxicology for Medical Examiners. USA,CRC Press.

| FSC-SEC-223 Emerging Trends in Forensic Science: Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/ Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-SEC-223 | Emerging Trends in Forensic Science: Theory | 3 | 0 | 0 | 3 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**

   To develop a basic understanding of emerging trends and techniques in forensic science.

2. **Course Learning Outcomes :**

   Understanding Modern Surveillance Tools, Advancements in Detection of Street Drugs, Geo-Forensics, Environmental Forensics, Wildlife Forensics.

**Unit-I: Modern Surveillance Tools** **8 hrs**

Surveillance using biometrics, ID cards, and communications data

Security Tools- Types (Airborne, Deployable, Fixed, Mobile, etc.), Advantages and Disadvantages.

**Unit-II: Advancements in Detection of Street Drugs** **10 hrs**

Kit based detection, Instrument Advancements in Drugs, Hyphenated Chromatographic, 2D Gas Chromatography, Electronic Nose, Advance Kits, Drug Early warning system, Non invasive matrix in drug detection, Non Conventional Substance of Abuse.

**Unit-III: Forensic Geology** **9 hrs**

Types of soil evidence, Color analysis, Particle analysis, Mineralogical analysis, Major and trace element composition, Procedures for soil and sediment sampling and storage, Analysis of gems/ colored stones, Evaluation of the significance of geological evidence.

**Unit-IV: Environmental Forensics** **10 hrs**

Introduction, Environmental pollutants, Toxicity of environmental contaminants, Fate of chemicals in the environment, Bioconcentration, Bioaccumulation and Biomagnification, Groundwater contamination, atmospheric dispersion of pollutants.

**Unit-V: WildLife Forensics** **8 hrs**

Introduction to Wildlife, Protected and Endangered Species of Animals and Plants, WildLife Species - Identification and Examination of Physical Evidence by Conventional and Modern Methods, Identification of Pug Marks of Various Animals,Wildlife Census, Wildlife and Environment Protection Act.

## Essential Readings:

1. Murray, R.C. and Tedrow, J.C.F. (1975). Forensic Geology. Rutgers University Press, New

Brunswick, New Jersey.

2. Murray, R.C. and Tedrow, J.C.F. (1992). Forensic Geology, 2nd ed. Prentice Hall Inc Englewood Cliffs, New Jersey.

3. Pye, K. (2007). Geological and soil evidence forensic applications, CRC Press, Taylor & Francis group.

4. Brian L. Murphy & Robert D. Morrison, Elsevier (Academic Press): Introduction to Environmental Forensics, 3rd edition (2015)

5. Jane E. Huffman, John R. Wallace Wildlife Forensics: Methods and Applications, Wiley Blackwell.

6. Beiglböck, C., &Walzer, C. (2019). Handbook on Standard Operating Procedures (SOP) in Forensic Investigations of Suspected Illegal Killing of Wildlife.

7. Fred Smith. Elsevier (Academic Press): Handbook of Forensic Drug Analysis, 1st edition (2004).

8. Rabi A. Musah. Springer: Analysis of Drugs of Abuse, 1st edition (2018).

9. Gupta, R. S. (1994). Management of internal security. New Delhi: Lancer Publishers.

10. Dipak, H. (1989). Industrial security in India. New Delhi: Ashish , Publishing House.

**Suggested Readings:**

1. Murray, R.C. (2004). Evidence from the Earth: Forensic Geology and Criminal Investigation. Mountain Press, Publishing Company, Missoula, Montana.

2. Petraco, N., Kubic, T. (2000). A density gradient technique for use in forensic soil analysis. Forensic Science International.

3. Reynolds, J.M. (1997). An introduction to applied and environmental geophysics. John Wiley & Sons, Ltd, Chichester.

4. Wildlife DNA Analysis: Applications in Forensic Science. (2013, May 28). Wiley.Com

| FSC-SEC-224 Emerging Trends in Forensic Science: Practical | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level/ Semester | Course Code | Title of the Course | Credit | | | | Marks | Course Coordinator |
| | | | L | T | P | C | | |
| L8 Sem II | FSC-SEC-224 | Emerging Trends in Forensic Science: Practical | 0 | 0 | 1 | 1 | IA(Mid)-40 EA(End Sem)- 60 | |

1. **Learning Objectives:**
   To give practical knowledge about the emerging trends and emerging techniques in the field of forensic science.
2. **Course Learning Outcomes :**
   Understanding about Identification and characterization of flora and fauna, drugs of abuse, soil, etc.

**List of Practicals** **30 hrs**

1. Pugmark Identification and characterization of common large mammals.
2. Use of different techniques in identification of different parts and products of flora and fauna reported in the wildlife trade.
3. To identify drugs of abuse by spot tests/rapid test kit.
4. To separate drugs of abuse by thin layer chromatography.
5. Comparison of soil samples.

## Essential Readings:


1. Murray, R.C. and Tedrow, J.C.F. (1975). Forensic Geology. Rutgers University Press, New Brunswick, New Jersey.

2. Murray, R.C. and Tedrow, J.C.F. (1992). Forensic Geology, 2nd ed. Prentice Hall Inc Englewood Cliffs, New Jersey.

3. Pye, K. (2007). Geological and soil evidence forensic applications, CRC Press, Taylor & Francis group.

4. Brian L. Murphy & Robert D. Morrison, Elsevier (Academic Press): Introduction to Environmental

Forensics, 3rd edition (2015)

5. Jane E. Huffman, John R. Wallace Wildlife Forensics: Methods and Applications, Wiley Blackwell.

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7. Fred Smith. Elsevier (Academic Press): Handbook of Forensic Drug Analysis, 1st edition (2004).

8. Rabi A. Musah. Springer: Analysis of Drugs of Abuse, 1st edition (2018).

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1. Murray, R.C. (2004). Evidence from the Earth: Forensic Geology and Criminal Investigation. Mountain Press, Publishing Company, Missoula, Montana.

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3. Reynolds, J.M. (1997). An introduction to applied and environmental geophysics. John Wiley & Sons, Ltd., Chichester.

4. Wildlife DNA Analysis: Applications in Forensic Science. (2013, May 28). Wiley.Com