

**GOVERNMENT INSTITUTE OF FORENSIC SCIENCE, NAGPUR**  
(An Autonomous Institute of Government of Maharashtra Affiliated to RTM Nagpur University)

# **SYLLABUS**

**MSc Forensic Science**

**Semester – III and Semester – IV**

**To be Implemented from Academic Year 2025-26**

## Examination Scheme: M. Sc. Forensic Science (Semester- III)

Sr. No.	Course Category	Name of Course	Course Code	Teaching Scheme (Hrs)		Total Credit	Examination Scheme						
				TH	P		Theory				Practical		
							Exam Hrs	SEE	CIE	Min	SEE	CIE	Min
<b>Specialization- I (Questioned Documents and Fingerprints)</b>													
1	DSC	Questioned Document Analysis - I	MFS3T01A	2	-	2	3	60	40	50	-	-	-
2	DSC	Advanced Fingerprint Development Method - I	MFS3T02A	2	-	2	3	60	40	50	-	-	-
3	DSC	Forensic Linguistics	MFS3T03A	2	-	2	3	60	40	50	-	-	-
4	DSC	Forensic Photography	MFS3T04A	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS3P01A	-	8	4	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS3T05A	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS3P02A	-	4	2	-	-	-	-	60	40	50
<b>Specialization- II (Forensic Chemistry and Toxicology)</b>													
1	DSC	Advanced Instrumentation-I	MFS3T01B	2	-	2	3	60	40	50	-	-	-
2	DSC	Advanced Forensic Chemistry - I	MFS3T02B	2	-	2	3	60	40	50	-	-	-
3	DSC	Advanced Forensic Toxicology - I	MFS3T03B	2	-	2	3	60	40	50	-	-	-
4	DSC	Advanced Chemistry	MFS3T04B	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS3P01B	-	8	4	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS3T05B	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS3P02B	-	4	2	-	-	-	-	60	40	50

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**Specialization-III (Forensic Biology and Serology)**

1	DSC	Forensic Biology and Entomology	MFS3T01C	2	-	2	3	60	40	50	-	-	-
2	DSC	Forensic Serology	MFS3T02C	2	-	2	3	60	40	50	-	-	-
3	DSC	DNA Fingerprinting - I	MFS3T03C	2	-	2	3	60	40	50	-	-	-
4	DSC	Microbial Forensics	MFS3T04C	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS3P01C	-	8	4	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS3T05C	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS3P02C	-	4	2	-	-	-	-	60	40	50

**Specialization-IV (Digital and Cyber Forensic)**

1	DSC	File System	MFS3T01D	2	-	2	3	60	40	50	-	-	-
2	DSC	Digital Image Processing	MFS3T02D	2	-	2	3	60	40	50	-	-	-
3	DSC	Network Forensics	MFS3T03D	2	-	2	3	60	40	50	-	-	-
4	DSC	Applied Cryptography	MFS3T04D	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS3P01D	-	8	4	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS3T05D	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS3P02D	-	4	2	-	-	-	-	60	40	50

**Specialization-V (Forensic Physics and Ballistics)**

1	DSC	Spectroscopy-I	MFS3T01E	2	-	2	3	60	40	50	-	-	-
2	DSC	X-Rays	MFS3T02E	2	-	2	3	60	40	50	-	-	-
3	DSC	Physical Evidence- I	MFS3T03E	2	-	2	3	60	40	50	-	-	-
4	DSC	Forensic Ballistics - I	MFS3T04E	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS3P01E	-	8	4	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS3T05E	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS3P02E	-	4	2	-	-	-	-	60	40	50

8	DSC	Special Law – I	MFS3T06	2	-	2	3	60	40	50	-	-	-
9	RP	Project	MFS3RP	-	8	4	-	-	-	-	60	40	50
<b>Total</b>				<b>12</b>	<b>20</b>	<b>22</b>		<b>360</b>	<b>240</b>	<b>300</b>	<b>180</b>	<b>120</b>	<b>150</b>

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*Bonni Milli Babey*

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## Examination Scheme: M. Sc. Forensic Science (Semester- IV)

Sr. No.	Course Category	Name of Course	Course Code	Teaching Scheme (Hrs)		Total Credit	Examination Scheme						
				TH	P		Theory				Practical		
							Exam Hrs	SEE	CIE	Min	SEE	CIE	Min
<b>Specialization- I (Questioned Documents and Fingerprints)</b>													
1	DSC	Questioned Document Analysis - II	MFS4T01A	2	-	2	3	60	40	50	-	-	-
2	DSC	Advanced Fingerprint Development Method - II	MFS4T02A	2	-	2	3	60	40	50	-	-	-
3	DSC	Forgery and Its Forensic Detection	MFS4T03A	2	-	2	3	60	40	50	-	-	-
4	DSC	Automated Fingerprint Identification System	MFS4T04A	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS4P01A	-	4	2	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS4T05A	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS4P02A	-	4	2	-	-	-	-	60	40	50
<b>Specialization- II (Forensic Chemistry and Toxicology)</b>													
1	DSC	Advanced Instrumentation-II	MFS4T01B	2	-	2	3	60	40	50	-	-	-
2	DSC	Advanced Forensic Chemistry - II	MFS4T02B	2	-	2	3	60	40	50	-	-	-
3	DSC	Advanced Forensic Toxicology - II	MFS4T03B	2	-	2	3	60	40	50	-	-	-
4	DSC	Pharmaceutical and Narcotic Drugs	MFS4T04B	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS4P01B	-	4	2	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS4T05B	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS4P02B	-	4	2	-	-	-	-	60	40	50

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**Specialization- III (Forensic Biology and Serology)**

1	DSC	Forensic Anthropology and Odontology	MFS4T01C	2	-	2	3	60	40	50	-	-	-
2	DSC	Wildlife and Environmental Forensics	MFS4T02C	2	-	2	3	60	40	50	-	-	-
3	DSC	DNA Fingerprinting- II	MFS4T03C	2	-	2	3	60	40	50	-	-	-
4	DSC	Thanatology and Forensic Pathology	MFS4T04C	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS4P01C	-	4	2	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS4T05C	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS4P02C	-	4	2	-	-	-	-	60	40	50

**Specialization- IV (Digital and Cyber Forensic)**

1	DSC	Steganography and Watermarking	MFS4T01D	2	-	2	3	60	40	50	-	-	-
2	DSC	Biometrics	MFS4T02D	2	-	2	3	60	40	50	-	-	-
3	DSC	Mobile Phone and Digital Device Forensics	MFS4T03D	2	-	2	3	60	40	50	-	-	-
4	DSC	Malware Forensics	MFS4T04D	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS4P01D	-	4	2	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS4T05D	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS4P02D	-	4	2	-	-	-	-	60	40	50

**Specialization- V (Forensic Physics and Ballistics)**

1	DSC	Spectroscopy-II	MFS4T01E	2	-	2	3	60	40	50	-	-	-
2	DSC	Radiation and Mass Spectrometry	MFS4T02E	2	-	2	3	60	40	50	-	-	-
3	DSC	Physical Evidence- II	MFS4T03E	2	-	2	3	60	40	50	-	-	-
4	DSC	Forensic Ballistics - II	MFS4T04E	2	-	2	3	60	40	50	-	-	-
5	DSC	Practical- I	MFS4P01E	-	4	2	-	-	-	-	60	40	50
6	DSE	Refer Elective Basket	MFS4T05E	2	-	2	3	60	40	50	-	-	-
7	DSE	Refer Elective Basket	MFS4P02E	-	4	2	-	-	-	-	60	40	50

8	DSC	Special Law – II	MFS4T06	2	-	2	3	60	40	50	-	-	-
9	RP	Project	MFS4RP	-	12	6	-	-	-	-	60	40	50
<b>Total</b>				<b>12</b>	<b>20</b>	<b>22</b>		<b>360</b>	<b>240</b>	<b>300</b>	<b>180</b>	<b>120</b>	<b>150</b>

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**Abbreviations:**

DSC: Discipline Specific Core, DSE: Discipline Specific Elective, RM: Research Methodology, Th: Theory, P: Practical, OJT: On-the-Job Training (Internship/Apprenticeship), FP: Field Project, SEE: Semester End Examination, CIE: Continuous Internal Evaluation, RP: Research Project

**Specializations:**

**SP- I: (A) Questioned Documents & Fingerprints**

**SP- II: (B) Forensic Chemistry & Toxicology**

**SP- III: (C) Forensic Biology & Serology**

**SP- IV: (D) Digital & Cyber Forensics**

**SP- V: (E) Forensic Physics & Ballistics**

{**Note:** The learner shall choose any one Specialization (allotment to be done on merit-cum-choice basis) at the beginning of Semester III and shall opt for the related papers and RP accordingly in Semester III & IV}

**Elective Paper:**

In addition to the mandatory papers, the learner must opt for ONE elective paper each in Semester III and Semester IV related to the specialization (from the Elective Basket\*).

*Handwritten signatures in blue ink:*  
A series of approximately ten handwritten signatures in blue ink, including names like "Yamini", "Srinivas", "Mullik Baby", "Ravi", "Hansi", "Sudha", "Anita", "Anurag", and "AD".

# Annexure- I

## Elective Basket

Name of Course		Course Code
<b>Semester- III</b>		
<b>Specialization I:</b> Questioned Documents and Fingerprints	Physical Security	MFS3T05A1 MFS3P02A1
	Forensic Accounting and Investigation Standards	MFS3T05A2 MFS3P02A2
<b>Specialization II:</b> Forensic Chemistry and Toxicology	Analytical Chemistry- I	MFS3T05B MFS3P02B
		MFS3T05C MFS3P02C
<b>Specialization III:</b> Forensic Biology and Serology	Techniques in Forensic Biology	MFS3T05D MFS3P02D
		MFS3T05E MFS3P02E
<b>Specialization IV:</b> Digital and Cyber Forensics	Image Forensics	MFS3T05E MFS3P02E
		MFS3T05E MFS3P02E
<b>Specialization V:</b> Forensic Physics and Ballistics	Electronics	MFS3T05E MFS3P02E
		MFS3T05E MFS3P02E
<b>Semester- IV</b>		
<b>Specialization I:</b> Questioned Documents and Fingerprints	Insurance Fraud Investigation	MFS4T05A1 MFS4P02A1
	Corporate Forensic Investigation	MFS4T05A2 MFS4P02A2
<b>Specialization II:</b> Forensic Chemistry and Toxicology	Analytical Chemistry- II	MFS4T05B MFS4P02B
		MFS4T05C MFS4P02C
<b>Specialization III:</b> Forensic Biology and Serology	Recombinant DNA Technology and Bioinformatics	MFS4T05D MFS4P02D
		MFS4T05E MFS4P02E
<b>Specialization IV:</b> Digital and Cyber Forensics	Computer Forensic and Digital Investigation	MFS4T05E MFS4P02E
		MFS4T05E MFS4P02E
<b>Specialization V:</b> Forensic Physics and Ballistics	Microscopy, Nephelometry, Turbidimetry and Thermal Methods	MFS4T05E MFS4P02E
		MFS4T05E MFS4P02E

\*Choose any one as per Specialization

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*VB*

*Biswini*

*Melli Babu*

*Shree*

*Hare*

*Sadhu*

*Praty*

*Amulya*

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# **Semester – III**

**Specialization – I**  
**Questioned Documents**  
**& Fingerprints**

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T01A: Questioned Document Analysis-I

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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**Course Outcomes:** On successful completion of this course, students will be able to:

1. Recognize the key elements and factors involved in the preliminary examination of documents, including handwriting characteristics and ink analysis techniques.
2. Apply knowledge of questioned document examination instruments and methods to analyze and interpret various types of writing materials, inks, and mechanical impressions.
3. Analyze handwriting samples and ink compositions to detect inconsistencies and potential forgeries, while also evaluating the age and authenticity of documents.
4. Integrate information from diverse sources to develop comprehensive forensic document examination reports, incorporating findings from handwriting analysis, ink analysis, and material examination.
5. Critically assess the reliability and validity of forensic document examination methods, considering their effectiveness in legal contexts and their adherence to ethical standards.

#### **Unit I: Preliminary Examination of Documents**

Various points of examination in Questioned Document, Examination of alphabets and numerals. Examination of vernacular scripts. Intrinsic and Extrinsic factors influencing Handwriting, Effect of mother tongue on foreign language, Effect of age, illness, posture, emotions, mental disorders and writing instrument on handwriting. Case studies.

#### **Unit II: Instruments in Questioned Document Analysis**

Working and handling of Stereo Zoom Microscopes, Comparison Microscope, Stereomicroscope, Video Spectral Comparator, Electrostatic Detection Apparatus, TLC, HPLC, HPTLC, FTIR, GC, GC-MS, AAS, UV-Visible Spectrophotometer, Pen line microscopy, Microscopic specular reflectance, Laser-induced fluorescence, Infrared luminescence.

#### **Unit III: Ink Analysis**

Historical development- Dating of fountain pen ink, ballpoint and Non ball point ink, Ink analysis and forensic document examination, Ink chemistry- recognition of ink source, chemical composition of Ink. Preliminary method of analysis- Introduction, Ink color assessment. Forensic Comparison and identification of writing ink. Ink aging process, relative age, absolute age.

#### **Unit IV: Examination of Writing Material**

Types of paper and other writing substrates, Analysis of paper, inks, raw materials, ingredients, and tagging materials. Estimation of age/dating of documents- Static Approach, Dynamic Approach, Supplementary Approach. Examination of mechanical impressions - examination of indentation marks, secret writings, examination of rubber stamp and seal impressions, embossed impressions.

**Suggested Readings:**

1. Forensic Handwriting Identification Fundamental concepts and Principles, Academic Press By Ron. Morris.
2. Suspect Documents, their Scientific Examinations, Nelson-Hall By W. Harrison
3. Scientific Examination of Questioned Documents, Second Edition, CRC Press, Taylor and Francis Group By Kelly, J.S. and Lindblom S.B.
4. Handwriting Identification: Facts and Fundamental, CRC Press, Boca Raton By Huber, R. A. and Headrick.
5. Scientific Examination of Questioned Documents, CRC Press By O.Hilton.
6. Law and Techniques relating to Identification of Handwriting, Disputed Documents, Fingerprints, Footprints. Revised by Atul Kumar Singla By B.L. Saxena
7. Treatise on handwriting forensics. Universal Law Publishing Co. New Delhi By B.R. Sharma
8. Scientific Examination of Documents: Methods and Techniques By D. Ellen
9. Encyclopedia of Forensic Sciences Edited By Jay A. Siegel & Pekka J. Sauko.

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T02A: Advanced Fingerprint Development Method-I

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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**Course Outcomes:** On successful completion of this course, students will be able to:

1. Demonstrate comprehension of various powder methods used in fingerprint development.
2. Apply techniques such as powder suspension methods for the development of latent fingerprints.
3. Analyze the history, mechanisms, and methods of application of fuming methods such as iodine fuming and cyanoacrylate fuming.
4. Evaluate the chemical methods used in fingerprint development by understanding their reaction mechanisms, procedures of development, pre- and post-treatment protocols, and associated health and safety precautions.
5. Understand fingerprint examination processes, including sufficiency determination, error rates, ACE-V methodology, and standards of examination, to prepare comprehensive reports and presentations as admissible evidence in various forensic applications.
6. Apply statistical and probability concepts to support fingerprint examination, identify limitations of current examination processes, and propose solutions to overcome challenges in forensic fingerprint analysis, considering factors such as error rates and reliability of evidence.

#### **Unit I: Powder Methods**

Traditional powder, Magnetic Powder, Luminescent powder, Thermoplastic Powder, Nanotechnology Powder, Anti-stroke Powder. Powder suspension technique: Small particle reagent, Black powder suspension, White powder suspension, fluorescent suspension, Operational usages and sequencing.

#### **Unit II: Fuming Methods**

Iodine Fuming Development Method: History, Mechanism of Iodine Fuming, Method of applications: Gun Fuming Method, Cabinet method, Dusting, Solution, Fixation, Method of Iodine fuming, pretreatment and post-treatment, Advantageous and Disadvantages.

Cyanoacrylate Fuming: History, Fingerprint development by cyanoacrylate fuming, Cyanoacrylate pre-treatment and post-treatment.

#### **Unit III: Chemical Methods**

Silver Nitrate & Reaction Mechanism: Mechanism of silver nitrate development of fingerprint, Procedure of development, pre- and post-treatment.

Chemistry & Reaction Mechanisms of Ninhydrin: Amino acid reagent, Forensic application. Metal salt enhancement, Ninhydrin analogous, Pre-treatment and Post-treatment. Health and safety precautions.

#### **Unit IV: Fingerprint Examination & its Statistical validation**

Admissibility of Fingerprint, Fingerprint examination process, determination of sufficiency at comparison stage and evaluation stage, Limitation of current fingerprint examination process, Error rates for examination of Fingerprint, Statistics and probability to support fingerprint examination. ACE-V in fingerprint examination. Standard of fingerprint examination. Report writing and presentation as evidence. Forensic applications in various fields. Technologies and case studies.

#### **Suggested Readings:**

1. Advances in Fingerprint Technology By Lee and Gaensslen's
2. Fingerprint Development Techniques Theory & Application By Stephen M. Bleay, Ruth S. Croxton, Marcel De Puit
3. Fundamentals of Fingerprint Analysis By Hillary Moses Daluz.
4. Advanced Forensic Science Series Forensic Fingerprints Edited By Max M. Houck.

**M. Sc. Forensic Science Semester - III**  
**DSC: MFS3T03A: Forensic Linguistics**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Outcomes:** On successful completion of this course, students will be able to:

1. Demonstrate comprehension of the principles and applications of forensic linguistics, including its role within applied linguistics and its various research areas.
2. Analyze phonetic and phonological features of speech to perform tasks such as voice identification, author identification, and dialect identification
3. Apply knowledge of morphology to analyze written texts, identify linguistic features, and detect linguistic anomalies, using techniques such as linguistic profiling and morphological analysis.
4. Critically evaluate the significance of psycholinguistic principles in literary forensics, including their application in authorship attribution and plagiarism detection.
5. Apply forensic linguistic techniques and methodologies to real-life cases, demonstrating the ability to identify unique linguistic traits, detect linguistic anomalies, and assess the authenticity of documents or speech recordings.

**Unit I: Forensic Linguistics & Phonology**

Forensic Linguistics, place of forensic linguistics in the applied linguistics, areas of research in the forensic linguistics. Phonetics and phonology, auditory phonetics, acoustics phonetics, voice identification, Author identification, Dialect identification, Discourse structure, Forensic phonetics, Speaker identification, Transcription.

**Unit II: Morphology in Forensic Linguistics**

Definition and scope of morphology, Basic concepts: morphemes, affixes, roots, stems. Role of morphology in analyzing written texts, Linguistic profiling: identifying linguistic features in texts. Analyzing word formation patterns. Identifying unique morphological traits in authors' writing, Detecting linguistic anomalies in texts. Assessing the authenticity of documents based on morphological analysis, Application of morphological analysis in real-life forensic linguistics cases.

**Unit III: Psycholinguistics and Literary Forensics**

Definition, Key concepts: Language processing, Language acquisition, Language disorders. The relationship found between Forensic linguistics and Psycholinguistics. Application of psycholinguistic principles to literary texts, Definition and scope of literary forensics, Methods of forensic analysis in literature: authorship attribution, plagiarism detection, Case studies in literary forensics.

**Unit IV: Tape (File) Authentication and Speaker Identification**

Vocal Anatomy and Voice Production Theory, Basic factors of sound in speech: pitch, intensity, duration. Acoustic characteristics of speech signal: formants, harmonics, and spectrogram. Fourier analysis, Frequency and time domain representation of speech signal, Process of analogue to digital conversion, Quantization and digitization of speech signal, Application of FFT in speech analysis and synthesis, Pattern Recognition in Speech. File Authentication and Speaker Identification.

## **Suggested Readings:**

1. An Introduction to Forensic Linguistics: Language in Evidence (2nd ed.). Routledge. Coulthard, M., Johnson, A., & Wright, D. (2017).
2. The Routledge Handbook of Forensic Linguistics (2nd ed.). Routledge. Coulthard, M., May, A., & Sousa-Silva, R. (Eds.). (2021).
3. Forensic Linguistics: An Introduction to Language in the Justice System. Blackwell Publishing. Gibbons, J. (2003).
4. Forensic Linguistics: An Introduction to Language, Crime and the Law (3rd ed.). Bloomsbury Publishing. Olsson, J., & Luchjenbroers, J. (2017).
5. Forensic Linguistics: Advances in Forensic Stylistics Edition: First Edition (2002) McMenamin, G. R .
6. Shuy, R. W. : Creating Language Crimes: How Law Enforcement Uses (and Misuses) Language Edition: First Edition (2005)
7. A Course in Phonetics Edition: 7th ed. (2014) Ladefoged, P., & Johnson, K. A.
8. International Handbook of Forensic Speaker Identification Edition: First Edition (2018) French, J. P., & Stevens, P. E.
9. The Language of Confession, Interrogation, and Deception First Edition (1998) :Shuy, R. W.
10. Forensic Linguistics Advances in Forensic Stylistics: Gerald R McMenamin

**M. Sc. Forensic Science Semester - III**  
**DSC: MFS3T04A: Forensic Photography**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Outcomes:** On successful completion of this course, students will be able to:

1. Demonstrate a foundational understanding of forensic photography, including the use of various photographic instruments.
2. Apply photography in various forensic contexts, including indoor and outdoor crime scenes.
3. Understand the role of photography in reconstructing crime scenes and presenting evidence in court.
4. Utilize advanced digital photography and videography techniques and understand their application in crime scene and laboratory settings.
5. Understand the legal aspects of visual evidence, including the admissibility of photographs and videography as evidence.
6. Demonstrate proficiency in specialized forensic imaging techniques and understand their significance in identifying and analyzing forensic evidence.

**Unit I: Basics of Forensic Photography**

Introduction, Photographic instruments, fundamentals of light and vision, light source, geometry and photometry of image formation, Types of cameras, Types of Lenses. Types of Camera Body, features, camera movement, and Optical filters. Film Camera vs Digital Camera. Working of Film and digital camera. Accessories in Forensic Photography.

**Unit II: Types of Photography**

History and Development of Photography. Basic principles and techniques of Black & White and colour photography, Photography in indoor and outdoor scene of crime; Aperture and focus adjustment. Photo prints: Developing techniques and methods of photography, Different kinds of developers and fixers, linkage of cameras and film negatives. Modern developments. Significance of Photography in Forensic Science.

**Unit III: Digital Photography & Videography**

Digital Imaging, Photogrammetric, Videography/highspeed Videography, crime scene and laboratory photography. Aerial Photography. Remote sensing & Geomapping. 3-D Photography/Videography, videography/high speed videography, High speed photography, Photography of various evidence, legal aspects of visual evidence, Juxtapose charts and demonstrative photographs, photographs as secondary evidence and their admissibility, case studies.

**Unit IV: Recent Advancements**

Specialized photography - UV, IR, transmitted light and side light photography, close-up, midrange and bird-eye view photography, trick photography, contact photography. Surveillance photography – Cameras and accessories for surveillance photography moving surveillance on foot, 2-person foot surveillance moving, surveillance with vehicles, fixed surveillance. Methods, techniques, and tactics. Issues and Case Studies. Recent Advancements in Forensic Photography & Videography.

**Suggested Readings:**

1. The Practical Methodology of Forensic Photography By David R. Redsicker
2. Advanced Crime Scene Photography By Christopher D. Duncan.
3. Crime Scene and Evidence Photography By Steven Staggs
4. Fundamentals of Forensic Photography By Keith Mancini
5. Forensic Photography By K. Mathew.
6. Encyclopedia of Forensic Sciences Edited By Jay A. Siegel & Pekka J. Sauko.

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3P01A: Practical - I**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 04**

**120 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Demonstrate the ability to operate and handle forensic instruments such as stereo zoom microscopes, comparison microscopes, and video spectral comparators for evidence analysis.
2. Apply powder, fuming, and chemical methods for the development of latent fingerprints and perform fingerprint comparison using the ACE-V approach.
3. Conduct forensic examination of questioned documents, paper, and inks, including the use of TLC and forensic stylistics for personal identification.
4. Utilize various crime scene photography techniques, including digital, surveillance, 3D visualization, and photogrammetry, for effective documentation and reconstruction of crime scenes.

**List of Practicals (Minimum of 12 have to be completed)**

1. Working and handling of Stereo Zoom Microscope for forensic analysis of evidence.
2. Working and handling of Comparison Microscope for forensic analysis of evidence.
3. Working and handling of Video Spectral Comparator for forensic analysis of evidence.
4. Development of latent prints by powder methods.
5. Development of latent prints by fuming methods.
6. Development of latent prints by chemical methods.
7. Fingerprint analysis and comparison using ACE-V approach.
8. To perform Forensic examination of Paper
9. To perform Forensic examination of ink.
10. To perform TLC of inks using different solvent systems.
11. Application of Forensic Stylistics in personal identification.
12. Study of psychological aspects of Suicide Notes/threatening letters/ransom notes encountered as evidence from scene of crime.
13. Speaker identification and tape(file) authentication.
14. Photography of Indoor and outdoor crime scene.
15. To perform various types of Surveillance Photography.
16. Digital photography of various evidences.
17. 3-Dimensional visualization of crime scene.
18. Photogrammetry of crime scene.

## M. Sc. Forensic Science Semester - III

### DSE: MFS3T05A1: Physical Security

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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**Course Outcomes:** On successful completion of this course, students will be able to:

1. Define key concepts of security and vigilance, including deterrence, detection, delay, and defense.
2. Evaluate case studies to identify and understand internal security threats and responses.
3. Describe various physical security technologies, including access control, barrier systems, and security sensors.
4. Explain the function and application of surveillance technologies, such as video management systems and video analytics.
5. Discuss the roles of police, paramilitary forces, and intelligence agencies in maintaining internal security and their participation in international security forums.

#### **Unit-I: Basics of Security Key Concepts of Security**

Definitions, Vigilance, (Deter, Detect, Delay, and Defend), National Security. Origins of Homeland Security: History, Homeland Security Concepts, Principles, Mission, Goals, Scope of Application. Domains of Homeland Security. Security Threats and Future Challenges. Case Study: 9/11 Attacks, 26/11 attacks, Mumbai Terror Attacks 2008, Samjhauta Express Bombing 2007, Pulwama Attack 2019, other cases.

#### **Unit-II: Understanding Internal Security**

Definition, Attributes, Elements of Internal Security - Socio-political stability, Territorial integrity, Economic solidarity, Ecological balance, Cultural cohesiveness, Moral-spiritual consensus, Peace and harmony. Theories of Internal Security (with illustrations): Securitization Theory, Balance of Power (BOP) Theory, Balance of Threat Theory, Security Dilemma Theory Internal Security Threats Economic and Financial crisis, Insurgency, Naxalism, Terrorism, Poverty, Organised Crime, Corruption, Illegal immigration, Natural & Manmade Disasters, Cybercrime. Case Study

#### **Unit-III: Physical Security Systems**

Technologies - Access Control Systems, Barrier Systems, Movement control, Security Sensors & Alarm systems, Fire prevention & response, Protective Equipment, Dog squad. Screening and Scanning technologies: UVSS, Backscatter, Computed tomography. Surveillance Technologies – Types of Cameras, Video Management System (VMS), Video Analytics, Video Surveillance as a Service (VSaaS). Web-based Security Management, Wireless Communication technologies. Authentication Technologies - Biometrics and Behavioural biometrics. Smart Card systems – Types, Smart Readers, System planning & deployment.

#### **Unit-IV: Combating Threats to Internal Security**

Importance of internal security for national stability and development, Strategies to counter threats to internal security, Economic espionage, National Security Policy, Border Management and Coastal Security, Strategies to counter terrorism, Role of Police and paramilitary forces, Role of Intelligence agencies NIA, IB, RAW. Participation in International forums, Cooperation with neighboring countries.

#### **Suggested Readings:**

1. Challenges to Physical Security of India By Ashok Kumar Singh.
2. India's Borders: Challenges and Response By P.D. Sharma
3. The Complete Guide to Physical Security By Paul R. Baker and Daniel J. Benny

**M. Sc. Forensic Science Semester - III**

**DSE: MFS3P02A1: Practical - II**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02**

**60 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Analyze real-world cases of terrorism and security breaches to identify security lapses and evaluate lessons learned for future preparedness.
2. Demonstrate an understanding of the components of internal security, including socio-political, economic, and territorial aspects, through case studies and scenario analysis.
3. Evaluate the roles and operations of national intelligence and security agencies in maintaining internal security and preventing threats.
4. Develop strategic responses to hypothetical security threats, incorporating intelligence gathering, inter-agency coordination, and counter-terrorism measures.
5. Assess and propose mitigation strategies for threats such as insurgency, terrorism, organized crime, and economic crises affecting national stability.

**List of Practicals (Minimum of 8 have to be completed)**

1. Conduct a detailed case study analysis of any one terror attack, focusing on the security lapses and lessons learned. (02)
2. Create a detailed report on the elements of internal security, including socio-political stability, territorial integrity, and economic solidarity, with real-world examples.
3. Research and present a report on the roles and operations of key intelligence agencies (NIA, IB, RAW) in maintaining internal security.
4. Analyze a real or hypothetical case of economic espionage. Discuss the methods used by the perpetrators and the countermeasures implemented.
5. Develop a counter-terrorism strategy for a hypothetical threat. Include aspects such as intelligence gathering, response by police and paramilitary forces, and international cooperation.
6. Analyze a case where intelligence agencies played a crucial role in preventing a security threat. Discuss the coordination between different agencies.
7. Create a scenario involving an economic crisis. Analyze the potential security implications and propose measures to ensure socio-political stability and economic solidarity.
8. Conduct a threat assessment for a given area, focusing on internal security threats such as insurgency, terrorism, and organized crime. Develop mitigation strategies.
9. Create a mock scenario of a security threat (e.g., a bomb threat or active shooter situation). Develop a response plan using the Deter, Detect, Delay, and Defend (4D) strategy. (02)
10. Examine the sequence of events, response by security forces, and subsequent policy changes following a security breach/threat. Identify key lessons learned.

## M. Sc. Forensic Science Semester - III

### DSE: MFS3T05A2: Forensic Accounting and Investigation Standards

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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**Course Outcomes:** On successful completion of this course, students will be able to:

1. Define and explain the key concepts of forensic accounting and forensic auditing.
2. Describe different types of auditing, including financial auditing, IT audits, information system audits, and information application audits.
3. Explain the purpose and applicability of ISO standards. Discuss the advantages and needs for implementing ISO standards.
4. Define and describe the types of risk and the differences between risk, threat, and vulnerability.
5. Identify key regulatory bodies such as CERTIN, RBI, SEBI, and understand their roles. Explain governance, risk management, and compliance (GRC) frameworks.
6. Identify and apply forensic accounting techniques to detect financial thefts, frauds, and other economic damages. Understand the role of forensic accounting in corporate evaluations and tax evasion investigations.

#### Unit I: Forensic Accounting

Introduction to Forensic Accounting, Forensic Auditing, Areas of Forensic Accounting, Forensic Accounting Audit Procedure, Types of Forensic Accounting- Financial Thefts, Security Fraud, Bankruptcy, Defaulting on Debt, Economic Damages, Tax Evasion, Corporate Evaluation, Types of Auditing- Financial Auditing, Information Technology Audit, Information System Audit, Information Application Audit.

#### Unit II: ISO Standards

Introduction to ISO, Applicability of ISO, Advantages of Implementation of ISO, Need of Implementing ISO, ISO 27001:2013, ISO 27001:2022, Transition Between ISO 27001:2013 and ISO 27001:2022, ISO 27002, ISO 31000, ISO 22301, Control Objectives for Information and Related Technologies (COBIT).

#### Unit III: Risk Management and Audits

Introduction to Risk, Types of Risk, Difference between Risk, Threat, and Vulnerability, Risk Management Process- Risk Identification, Risk Analysis, Statement of Applicability, Risk Treatment Plan, Ways of Treating Risk, Implementing Necessary Controls, Risk Mitigation and Audits.

#### Unit IV: Rules and Regulations

Regulatory Bodies- CERTIN, RBI, SEBI, GRC (Governance, Risk Management, Compliance), HIPAA (Health Insurance Portability and Accountability Act), GDPR (General Data Protection Regulation), DPDPA (Digital Personal Data Protection Act), Intermediary Guidelines 2023, Anti-Corruption Regulations in India, Applicability of these Regulations.

#### Suggested Readings:

1. Forensic Accounting and Fraud Examination, Mary-Jo Kranacher, Richard Riley, Joseph T. Wells
2. Information Security Risk Management for ISO 27001/ISO 27002, Alan Calder
3. Risk Management in Organizations: An Integrated Case Study Approach, Margaret Woods
4. Auditing and Assurance for CA IPCC, Surbhi Bansal
5. ISO/IEC 27001:2022 Information security, cybersecurity and privacy protection, International Organization for Standardization (ISO)

**M. Sc. Forensic Science Semester - III**

**DSE: MFS3P02A2: Practical - II**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02**

**60 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Analyze financial fraud and forensic accounting cases to identify investigation procedures, evidence collection methods, and reporting protocols.
2. Conduct forensic audits and IT audits to detect financial irregularities, assess compliance with standards, and evaluate system vulnerabilities.
3. Compare and evaluate ISO and regulatory frameworks (e.g., ISO 27001, ISO 31000, GDPR) for their relevance in improving security, risk management, and operational compliance.
4. Develop risk management and data protection strategies for organizations, incorporating industry standards and regulatory guidelines to ensure legal and ethical compliance.
5. Understand and explain the roles of key regulatory bodies such as CERT-IN, RBI, and SEBI in maintaining cybersecurity, financial stability, and regulatory enforcement.

**List of Practicals (Minimum of 8 have to be completed)**

1. Study a case involving a financial theft/fraud and identify the steps taken in a forensic accounting investigation, including gathering evidence and reporting findings. (02)
2. Conduct a mock forensic audit of a small business, focusing on identifying and documenting financial irregularities.
3. Analyze a bankruptcy case to identify signs of fraudulent activity. Prepare a report detailing the findings and recommendations.
4. Investigate a hypothetical case of tax evasion, documenting the methods used to detect the evasion and the steps taken to address it.
5. Perform an IT audit on a sample company, evaluating its information systems for compliance with industry standards and identifying potential security risks.
6. Research and present a report on the advantages and need for implementing ISO standards in a specific industry/laboratory.
7. Conduct a comparative analysis of ISO 27001:2013 and ISO 27001:2022, highlighting the key differences and the transition process.
8. Create a risk management framework based on ISO 31000 for a case study organization, identifying potential risks and mitigation strategies.
9. Create a risk mitigation strategy for a specific risk scenario, including preventive and corrective measures.
10. Develop a data protection strategy for an organization to comply with GDPR, including data handling, storage, and breach response measures.
11. Research and present a report on the roles and responsibilities of CERTIN, RBI, SEBI, and other regulatory bodies in maintaining security and compliance.

**Specialization – II**  
**Forensic Chemistry &**  
**Toxicology**

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T01B: Advanced Instrumentation – I

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives:

1. To introduce students to the principles and applications of modern spectroscopic techniques used in forensic chemistry.
2. To develop a strong foundation in atomic, infrared, and nuclear magnetic resonance spectroscopy.
3. To enable students to understand instrumentation design, operational principles, and analytical interpretation of spectral data.
4. To emphasize the forensic applications of spectroscopic methods in qualitative and quantitative analysis.
5. To build analytical and problem-solving skills through case studies and problem-based learning in forensic analysis.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Understand the theoretical background and working principles of atomic, infrared, and NMR spectroscopy.
2. Demonstrate knowledge of instrumentation and operational techniques in spectroscopy.
3. Interpret and analyze UV-Vis, IR, and NMR spectra for chemical structure elucidation.
4. Apply spectroscopic methods to forensic case studies for qualitative and quantitative analysis.
5. Develop critical thinking and independent analytical skills in solving forensic chemistry problems.

#### Unit I: Atomic spectroscopy

Introduction to atomic and molecular spectroscopy, Jablonski diagram, comparative account of atomic and molecular spectroscopy. Ultraviolet-visible spectroscopy, Types of electronic transitions, UV-Spectrophotometer (Light Source Monochromator Sample Area Detector and Recorder) Types of UV/Visible spectrophotometer, Absorption laws and Forensic applications

#### Unit II: Infrared Spectroscopy

Principle, concept of dipole moment, types of IR active vibrations, Instrumentation, IR sources, dispersive and Fourier Transform IR spectroscopy, Michelson interferometer, Attenuated Total Reflectance FT-IR, Group frequencies for common organic functional groups, Systematic interpretation of IR spectrum, Applications of IR Spectroscopy

#### Unit III: Nuclear Magnetic Resonance (NMR) I

Introduction, Nuclear Magnetic Resonance (NMR) Spectroscopy, NMR active Nuclei, Relaxation processes, Spin - Lattice Relaxation, Spin - spin Relaxation, Shielding and deshielding, Instrumentation of NMR spectroscopy (Continuous wave (CW) or field sweep instruments, Fourier Transform (FT) NMR instruments) Sample handling in NMR, Chemical Shift Values, Measurement of chemical shift, factors affecting chemical shift, Introduction to <sup>13</sup>C NMR

#### Unit IV: Nuclear Magnetic Resonance (NMR) II

Number of Signals: Chemical Equivalence and Non-equivalence, Tests for the equivalence of protons, Signal Area, Spin-spin Interactions, Coupling constant, Factors affecting the coupling constant, Chemical shift values for various functional groups, Alkanes, Alkenes and conjugated system, Aromatic Compounds, Alkynes, Alkyl halides, Alcohols, Ethers, Amines, Nitriles, Nitro alkanes, Aldehydes, Ketones, Esters, Carboxylic acid Amides, Problem based on <sup>1</sup>H and <sup>13</sup>C NMR, Use of NMR in Forensic analysis.

## Suggested Readings:

1. Skoog, Douglas A., Holler, F. James, & Crouch, Stanley R. – *Principles of Instrumental Analysis* – 7th Edition
2. Willard, Hobart H., Merritt, Lynne L., Dean, John A., & Settle, Frank A. – *Instrumental Methods of Analysis* – 7th Edition
3. Holler, F. James, Skoog, Douglas A., & Crouch, Stanley R. – *Analytical Chemistry: An Introduction* – 7th Edition
4. Silverstein, Robert M., Webster, Francis X., Kiemle, David J., & Bryce, David L. – *Spectrometric Identification of Organic Compounds* – 8th Edition
5. Banwell, C. N., & McCash, E. M. – *Fundamentals of Molecular Spectroscopy* – 4th Edition
6. Pavia, Donald L., Lampman, Gary M., Kriz, George S., & Vyvyan, James R. – *Introduction to Spectroscopy* – 5th Edition
7. Harvey, David – *Modern Analytical Chemistry* – 1st Edition
8. Kemp, William – *Organic Spectroscopy* – 3rd Edition
9. Das, A. K. – *Fundamental Concepts of Inorganic Chemistry: Spectroscopy and Instrumental Techniques* – 1st Edition
10. Chatwal, Gurdeep R., & Anand, Sham K. – *Instrumental Methods of Chemical Analysis* – 5th Edition
11. Harris, Daniel C. – *Quantitative Chemical Analysis* – 10th Edition
12. Heathcote, D. G. – *Modern Analytical Techniques* – 1st Edition
13. Crouch, Stanley R., & Skoog, Douglas A. – *Principles of Instrumental Analysis Lab Manual* – 1st Edition
14. Gottfried, J. L., & Snell, F. D. – *Introduction to Chemical Instrumentation* – 2nd Edition
15. Williams, Donald H., & Fleming, Ian – *Spectroscopic Methods in Organic Chemistry* – 6th Edition

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T02B: Advanced Forensic Chemistry – I

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives:

1. Provide fundamental knowledge of the chemistry of fire, arson, and explosions, with emphasis on forensic investigation and analysis.
2. Develop an understanding of different types of explosives, explosive devices, their mechanisms, and forensic approaches for post-blast investigation.
3. Impart knowledge of petroleum products, their chemical properties, adulterants, and analytical methods for detection and forensic applications.
4. Introduce cement, concrete, and mortar analysis, focusing on sampling methods, adulteration detection, and forensic significance.
5. Train students to apply scientific techniques and analytical tools in the examination of fire debris, explosives, petroleum products, and construction materials for forensic casework.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. The chemistry of fire, comparison between fire and arson, motives of arson, room-fire sequence, management of arson cases, role of investigator in fire/arson case, extraction and analysis methods of arson exhibits and scientific report writing.
2. The chemistry of explosion reaction, classification of explosives, Explosion process and effects, steps involved in managing the crime scene of explosion, collection of post-blast residues.
3. Various types of explosive devices such as bomb and its type, Improvised Explosive Devices (IEDs) and its components, Molotov cocktail, Disposal of bombs.
4. Various types of petroleum products, their composition and chemical properties, types of distillation processes, adulterants and their detection in petroleum products, Gas chromatographic analysis of petrol, diesel and kerosene, Detection of adulteration by Flash point, Aniline point, Smoke point and boiling point.

#### Unit I: Arson: Investigation and Analysis

Introduction, Chemistry of fire, Motives of arson, Phases of combustion, Pattern followed by Fire, Management of arson scene, Role of first respondent and fire investigating officer, Extraction and analysis of arson exhibits, Advantages and disadvantages of various extraction techniques, Scientific report writing

#### Unit II: Explosives: Investigation and Analysis

Classification of Explosives, Explosion process and types of Explosions, Manufacturing of some common explosives, Crime scene management of explosion site, collection of evidences, Analysis of explosive ions

**Post-blast Investigation:** Bombs, Types of Bombs, Improvised Explosive Devices (IEDs), Molotov cocktail, Disposal of bombs, Role of Forensic Scientist in Post-blast investigation,

#### Unit III: Petroleum Products

Composition of petroleum products and their chemical properties, Fractional distillation and relative processes, common adulterants in petroleum products, Detection of adulterants in gasoline, diesel and engine oils, Gas chromatography analysis of petrol, kerosene, diesel and other solvents, Detection of adulteration by Flash point, Aniline point, Smoke point, boiling point, and distillation method, Analysis of recycled engine oil.

#### **Unit IV: Cement**

**Cement, Concrete and Mortar:** Chemical composition of Portland cement and other type of cements; Methods of sampling of cements, mortar and concrete; Common adulterants of cement and their detection. Methods of analysis: Physical analysis Sieve test, microscopic examination, Ignition tests, Density Gradient test. Chemical analysis of cement, mortar and concrete.

#### **Suggested Readings:**

1. B. R. Sharma: Forensic Science in Criminal Investigation and Trials, Fourth Edition, Universal Law Publishing
2. Modi's: Medical Jurisprudence & Toxicology, M. M. Trirathi Press Ltd. Allahabad, 1988.
3. S. N. Tiwari: Analytical Toxicology, Govt. of India Publications, New Delhi, 1987.
4. Curry: Analytical Methods in Human Toxicology, Part II, 1986.
5. P.R. Brown and E. Bruksha: Advances in Chromatography, Vol. 42, 2003.
6. Howard: Forensic Analysis by Gas Chromatography
7. B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.
8. R.A. Day and A.L. Underwood, Quantitative Analysis, 6th Ed., Prentice Hall of India Pvt.Ltd (1993).
9. G.D. Christian, Analytical Chemistry, 6th Ed., John Wiley & Sons (2001).
10. B. Levine: Principles of Forensic Toxicology, 3rd Ed., AACC Press, 2010.
11. K.N. Rao: Forensic Toxicology, CRC Press, 2012.
12. Samford : Poisons Their Isolation Identification.
13. Dubois and Celling: Textbook of Toxicology.
14. R. C. Froede: The Laboratory Management of the Medico-Legal, Specimen
15. DFS –Working Procedure Manual Chemistry, Explosives and Narcotics.
16. Feigl: Spot Test in Organic Analysis, Elsevier Pub., New Delhi (2005)
17. Jehuda Yinon: Forensic and Environmental Detection of Explosives
18. Yinon Jitrin: Modern Methods & Application in Analysis of Explosives, John Wiley & Sons England (1993)
19. M. M. Houck & J.A. Siegel: Fundamentals of Forensic Science, Academic Press, London, 2006.
20. N.C. Asthana and Nirmal Anjali: The Ultimate Book of Explosives, Bombs and I E
21. Ds, Pointer Publishers (2008).
22. T. Suceska: Test Methods for Explosives, Springer (1995).
23. D. K. Molina: Handbook of Forensic Toxicology for Medical Examiners, CRC Press, 2009.
24. T. Altug: Introduction of Toxicology and Food, CRC Press, 2012.

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T03B: Advanced Forensic Toxicology – I

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives:

1. To familiarize students with various techniques for the extraction and isolation of poisons from biological and non-biological specimens.
2. To impart in-depth knowledge of organic poisons, including their nature, toxicological effects, medico-legal relevance, and methods of analysis.
3. To provide a comprehensive understanding of metallic poisons and their detection using qualitative and instrumental methods.
4. To explore the toxicological profile and forensic significance of non-metallic poisons, including halogens and cyanides.
5. To train students in the application of classical and modern analytical techniques, including color tests, chromatography, and spectroscopy, for poison identification.

#### Course Outcomes: On successful completion of this course, students will be able to:

1. Students will be able to apply appropriate extraction techniques for isolating poisons from forensic samples like blood, urine, and food.
2. Students will demonstrate understanding of the toxicokinetics, symptoms, and medico-legal aspects of various organic poisons such as alcohols, ethers, and halogenated compounds.
3. Students will analyze and interpret the toxic effects, fatal doses, and post-mortem findings associated with common metallic poisons using color tests and instrumental methods.
4. Students will identify non-metallic poisons and assess their forensic relevance through chemical and instrumental analysis.
5. Students will develop the ability to select and perform suitable analytical techniques for qualitative and quantitative detection of poisons in forensic investigations.

#### Unit I: Methods of Extraction of Poison

Solvent extraction, fractional distillation /steam distillation, dialysis, dry ashing, wet digestion, modified Stas-Otto method, ammonium sulphate method. Extraction of poisons from blood, urine, stomach washes and vomits, food material

#### Unit II: Organic Poisons

Nature, use, administration, symptoms, post-mortem findings, fatal dose, fatal period and medico-legal significance of: Methanol, Ethanol, Ether, Phenols, Camphor, Chloral Hydrate, Chloroform, Carbon tetrachloride, etc. Analysis by colour tests, chromatographic and instrumental techniques.

#### Unit III: Metallic Poisons

Nature, use, administration, symptoms, post-mortem findings, fatal dose and fatal period of metallic poisons: Lead, Copper, Mercury, Arsenic, Barium, Cadmium, Chromium, Zinc, Antimony, Thallium, etc. Analysis by colour tests and instrumental techniques.

#### Unit IV: Non-metallic Poisons

Nature, use, administration, symptoms, post-mortem findings, fatal dose and fatal period of non-metallic poisons: chlorine, bromine, iodine, cyanide, thiocyanate, etc. Analysis by colour tests and instrumental techniques.

## Suggested Readings:

1. Vogel's Textbook of Quantitative Chemical Analysis – J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas. *Pearson Education*.
2. Fundamentals of Analytical Chemistry – Douglas A. Skoog, Donald M. West, F. Holler, Stanley R. Crouch. *Cengage Learning*.
3. Instrumental Methods of Analysis – Willard, Merritt, Dean & Settle. *CBS Publishers*.
4. Modern Analytical Chemistry – David Harvey. *McGraw-Hill Education*.
5. Analytical Toxicology for Clinical, Forensic and Pharmaceutical Chemists – Hans H. Maurer. *Wiley-VCH*.
6. Clarke's Analysis of Drugs and Poisons – Anthony C. Moffat, David M. Osselton, Brian Widdop. *Pharmaceutical Press*.
7. Casarett and Doull's Toxicology: The Basic Science of Poisons – Curtis D. Klaassen. *McGraw-Hill Education*.
8. Principles of Forensic Toxicology – Barry Levine. *Springer Publishing*.
9. Forensic Toxicology: Principles and Concepts – Nicholas T. Lappas, Randy M. Isenschmid. *CRC Press (Taylor & Francis)*.
10. Forensic Toxicology: Drug Use and Misuse – Olaf H. Drummer. *Wiley*.
11. Forensic Toxicology: Mechanisms and Analytical Methods – A. K. Gupta. *CRC Press (Taylor & Francis)*.
12. Forensic Chemistry Handbook – Lawrence Kobilinsky. *Wiley*.
13. Forensic Chemistry – Suzanne Bell. *Pearson Education*.
14. Forensic Science: An Introduction to Scientific and Investigative Techniques – Stuart H. James, Jon J. Nordby. *CRC Press (Taylor & Francis)*.
15. Textbook of Forensic Medicine and Toxicology – Anil Aggrawal. *Avichal Publishing Company*.
16. A Textbook of Forensic Medicine and Toxicology – K.S. Narayan Reddy. *CBS Publishers*.
17. Analytical Toxicology – Irving Sunshine. *Wiley*.
18. Handbook of Toxicology – Michael J. Derelanko, Carol S. Auletta. *CRC Press (Taylor & Francis)*.
19. Forensic Science Handbook (Vol. II) – Richard Saferstein. *Pearson Education*.
20. Practical Forensic Toxicology: Examination and Interpretation – Ambika Prasad Mishra. *CRC Press (Taylor & Francis)*.
21. Fundamentals of Analytical Toxicology – Robert H. Hill. *CRC Press (Taylor & Francis)*.
22. Forensic Science in Toxicology – Alan D. King. *Wiley*.
23. Forensic Medicine – P. Umadethan. *Jaypee Brothers Medical Publishers*.
24. A Textbook of Medical Jurisprudence and Toxicology – Modi. *LexisNexis / Butterworths India*.

**M. Sc. Forensic Science Semester - III**  
**DSC: MFS3T04B: Advanced Chemistry**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives:**

1. Provide an in-depth understanding of chemical and biological warfare agents, their properties, toxic effects, and detection methods.
2. Develop knowledge of industrial toxicology, including sources, mechanisms, dose-response relationships, and forensic significance.
3. Introduce nanotoxicology concepts, focusing on mechanisms, health hazards, and forensic applications.
4. Enhance analytical and critical thinking skills required in forensic chemistry and toxicology investigations.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Explain the classification, properties, and effects of chemical and biological warfare agents, along with their detection and safety measures.
2. Analyze the toxicological effects of industrial chemicals and evaluate preventive and clinical measures in forensic contexts.
3. Evaluate nanotoxicology principles, including mechanisms, routes of exposure, and forensic significance.

**Unit I: Chemical warfare agents**

Introduction, classification, physical and biochemical properties, toxic effects, detection by sensors and other instrumental methods, prevention and safety measures, current scenario about use of chemical weapons.

**Unit II: Biological warfare agents**

Introduction, Categories of biological weapons, study of potential bacteria, fungi, viruses, and their toxins, mode of action, identification, prevention and safety measures, current scenario about use of biological weapons.

**Unit III: Industrial Toxicology**

Introduction, sources of toxicity, forms of toxicity, dose-response relationship, factors affecting toxicity, health hazards, prevention and safety measures, clinical toxicology, and forensic significance.

**Unit IV: Nanotoxicology**

Introduction, sources of toxicity, routes of administration, mechanism of toxicity, factors affecting toxicity, health hazards, methods of analysis, prevention and safety measures, forensic significance.

## Suggested Readings:

1. Aselt, R. C. (2021). *Disposition of toxic drugs and chemicals in man* (12th ed.). Biomedical Publications.
2. Bell, S. (2019). *Forensic chemistry* (2nd ed.). CRC Press.
3. Inman, K., & Rudin, N. (2010). *Principles and practice of criminalistics: The profession of forensic science* (2nd ed.). CRC Press.
4. Karch, S. B. (2017). *Drug abuse handbook* (2nd ed.). CRC Press.
5. Karch, S. B., & Drummer, O. H. (2012). *Karch's pathology of drug abuse* (5th ed.). CRC Press.
6. Langford, N. J. (2011). *Introduction to forensic toxicology* (1st ed.). CRC Press.
7. Levine, B. (2016). *Principles of forensic toxicology* (5th ed.). American Academy of Forensic Sciences.
8. Levine, B., & Blanke, R. V. (2005). *Handbook of forensic drug analysis* (1st ed.). Academic Press.
9. Moffat, A. C., Osselton, M. D., & Widdop, B. (2011). *Clarke's analysis of drugs and poisons* (4th ed.). Pharmaceutical Press.
10. Pragst, F., & Balikova, M. A. (2006). *Forensic toxicology: Drug use and misuse* (1st ed.). Elsevier.
11. Oberdörster, G., Maynard, A., Donaldson, K., et al. (2005). *Nanotoxicology: An emerging discipline evolving from studies of ultrafine particles* (1st ed.). Elsevier.
12. Borm, P. J. A., & Kreyling, W. (2004). *Nanoparticles: Toxicology and safety* (1st ed.). CRC Press.
13. Nel, A., Xia, T., Mädler, L., & Li, N. (2006). *Nanomaterial toxicity and environmental impact* (1st ed.). Springer.
14. Stone, V., & Monteiro-Riviere, N. A. (2010). *Nanotoxicology and nanomedicine: Safety assessment of nanomaterials* (1st ed.). CRC Press.
15. Klaine, S. J., et al. (2008). *Nanomaterials in the environment: Behavior, fate, bioavailability, and effects* (1st ed.). Wiley.
16. Seinfeld, J. H., & Pandis, S. N. (2006). *Industrial toxicology: Exposure, risk, and safety* (1st ed.). Wiley.
17. Casarett, & Doull, J., & Klaassen, C. D. (2013). *Casarett & Doull's toxicology: The basic science of poisons* (9th ed.). McGraw-Hill Education.
18. Lloyd, R. V., et al. (2003). *Industrial toxicology handbook* (1st ed.). CRC Press.
19. Jeyaratnam, J. (1985). *Occupational toxicology* (1st ed.). CRC Press.
20. Lehmann, I., & Fitzhugh, O. G. (1954). *Industrial chemical safety and toxicology* (1st ed.). McGraw-Hill.

## M. Sc. Forensic Science Semester - III

### DSC: MFS3P01B: Practical - I

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 04

120 Lectures/Semester

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Perform qualitative and quantitative analysis of toxic substances, including pesticides, insecticides, dyes, and pigments, using chemical and instrumental methods such as UV-Visible spectrophotometry and TLC.
2. Demonstrate proficiency in the extraction, derivatization, and instrumental analysis (GC-MS, HPTLC, FTIR) of biological and non-biological samples for detection of poisons and drugs.
3. Analyze and interpret toxicological evidence from biological specimens (blood, urine, viscera, stomach wash) in cases of suspected poisoning and substance abuse.
4. Apply classical and modern analytical techniques for identification of metallic and non-metallic poisons in biological matrices.
5. Evaluate and interpret spectral and chromatographic data to identify unknown compounds and correlate findings with forensic and toxicological significance.

#### List of Practicals (Minimum of 12 have to be completed)

1. To perform Color test and UV-Visible Spectrophotometry of pesticide, insecticides. (2)
2. Analysis of dye and pigments by using TLC technique.
3. Analysis of alcohol content in sample by derivatization into known organic compounds and its analysis by GC-MS.
4. Analysis of Mercury in biological materials by Fresenius-Babo method.
5. Analysis of animal Poisons using TLC.
6. Analysis of Plant poisons using TLC. (2)
7. Determination of alcohol in blood and urine sample.
8. Analysis of blood, urine, stomach wash in emergency cases of poisoning.
9. Comparison of fibres by chemical analysis, TLC/ HPTLC/ FTIR. (2)
10. Gas chromatography analysis of Ganja and Charas.
11. Analysis of food material in case of food poisoning by chemical, microscopic and instrumental techniques. (2)
12. Analysis of viscera in case of food poisoning by chemical, microscopic and instrumental techniques. (2)
13. Analysis of viscera for volatile organic and inorganic poisons.
14. Analysis of non- metallic (anionic) poisons in viscera. (2)
15. Analysis of metallic (anionic) poisons in viscera. (2)
16. Interpretation of given spectral data of various compounds. (2)

#### Suggested Readings

1. Vogel's Textbook of Quantitative Chemical Analysis – J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas. *Pearson Education*.
2. Vogel's Textbook of Practical Organic Chemistry – A.I. Vogel. *Pearson Education*.
3. Practical Forensic Microscopy: A Laboratory Manual – Barbara Wheeler & Lori J. Wilson. *CRC Press*.
4. Forensic Chemistry Handbook – Lawrence Kobilinsky. *Wiley*.
5. Forensic Science: An Introduction to Scientific and Investigative Techniques – Stuart H. James & Jon J. Nordby. *CRC Press*.
6. Forensic Toxicology: Principles and Concepts – B.K. Sharma. *Krishna Prakashan Media*.
7. Modi's Textbook of Medical Jurisprudence and Toxicology – Jaising P. Modi. *LexisNexis*.

8. Principles of Forensic Medicine and Toxicology – P.V. Guharaj & P. Umadethan. *Jaypee Brothers Medical Publishers*.
9. Forensic Toxicology – Alan D. Marshall & Fiona M. W. Donnelly. *CRC Press*.
10. Handbook of Toxicology – Michael J. Derelanko & Carol A. Auletta. *CRC Press*.
11. Chromatography: Concepts and Contrasts – James M. Miller. *Wiley*.
12. Gas Chromatography and Mass Spectrometry: A Practical Guide – O. David Sparkman, Zelda Penton, Fulton G. Kitson. *Academic Press*.
13. Introduction to Instrumental Analysis – Robert D. Braun. *McGraw-Hill*.
14. Instrumental Methods of Chemical Analysis – H. Kaur. *Pragati Prakashan*.
15. Forensic Science Laboratory Manual and Workbook – Thomas J. Catalano. *CRC Press*.
16. Textbook of Forensic Chemistry and Toxicology – S.K. Goyal. *CBS Publishers*.
17. Analytical Toxicology for Clinical, Forensic, and Pharmaceutical Chemists – Hans H. Maurer. *Wiley-VCH*.
18. Modern Analytical Chemistry – David Harvey. *McGraw-Hill Education*.
19. Analytical Chemistry – Gary D. Christian. *John Wiley & Sons*.
20. Forensic and Environmental Detection of Drugs – R. G. Cooks & R. E. March. *CRC Press*.

**M. Sc. Forensic Science Semester - III**  
**DSE: MFS3T05B: Analytical Chemistry -I**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives:**

1. To introduce students to the fundamental concepts and principles of analytical chemistry, focusing on chromatographic and spectroscopic techniques.
2. To develop an understanding of various modern analytical instruments used in chemical and forensic laboratories.
3. To enable students to analyze and interpret results from Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), and Atomic Absorption Spectroscopy (AAS).
4. To impart practical skills in qualitative and quantitative analysis for the identification of chemical substances in forensic samples.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Students will understand the theoretical principles and practical aspects of chromatographic techniques such as column, paper, TLC, HPTLC, GC, and HPLC.
2. Students will be able to explain the instrumentation and functioning of analytical tools such as GC-MS, LC-MS, Flame Photometer, and Atomic Absorption Spectrometer.
3. Students will acquire the ability to interpret chromatographic and spectroscopic data to identify chemical and biological substances.

**Unit I: Chromatography**

Introduction, review of basic principles and types of chromatography, column chromatography, paper chromatography, TLC and HPTLC: Principle, Theory instrumentation, visualization, Qualitative and Quantitative concepts and Forensic applications

**Unit II: GAS Chromatography**

Introduction, Principle of Gas chromatography Gas- Liquid Chromatography, Instrumentation, Carrier gas Sample injection system, Separation system, Detectors, Thermostat chambers, Recorder system, Identifications of various chemicals, Advantages of Gas Chromatography, Forensic Applications of GC-MS

**Unit III: High Performance Liquid Chromatography**

Introduction, Principle of High-Performance Liquid Chromatography (HPLC), Instrumentation, Types of HPLC, Mobile phases, injectors, pumps, columns, Forensic Applications of HPLC technique, Identifications of various drugs, pesticides, explosive, snake venom and blood samples, Liquid Chromatography–Mass Spectrometry (LC–MS)

**Unit IV: Analytical Methods**

**Flame Photometry:** Principle, theory, instrumentation, working and forensic applications

**Atomic Absorption Spectroscopy:** Principle, theory, instrumentation, working and forensic applications

**Turbidometry:** Light Scattering, Concentration and Scattering, Instrumentation of turbidometry, general procedure for operation, Turbidimetric titration, Forensic application.

## Suggested Readings:

1. Snyder, Lloyd R., Kirkland, Joseph J., & Dolan, John W. – *Introduction to Modern Liquid Chromatography* – 3rd Edition
2. Braun, R. D. – *Introduction to Practical Chromatography* – 3rd Edition
3. Harborne, J. B. – *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis* – 3rd Edition
4. Harris, Daniel C. – *Quantitative Chemical Analysis* – 10th Edition (includes chromatography techniques)
5. Pavia, Donald L., Lampman, Gary M., Kriz, George S., & Vyvyan, James R. – *Introduction to Organic Laboratory Techniques: A Microscale Approach* – 5th Edition (covers TLC, column, and paper chromatography)
6. Chatwal, G. R., & Anand, Sham K. – *Instrumental Methods of Chemical Analysis* – 5th Edition (includes chromatography)
7. Poole, Colin F. – *Gas Chromatography* – 7th Edition
8. Felinger, Attila – *High-Performance Liquid Chromatography: Principles and Methods in Biotechnology* – 2nd Edition
9. Gross, Michael L., & Caprioli, Richard M. – *The Encyclopedia of Mass Spectrometry and Chromatography* – 1st Edition
10. McNair, Harold M., & Miller, James M. – *Basic Gas Chromatography* – 2nd Edition
11. Rogers, R. J., & Foreman, R. – *Practical High-Performance Liquid Chromatography* – 2nd Edition
12. Meyer, Victor R. – *Practical High-Performance Liquid Chromatography* – 5th Edition
13. Krause, William J. – *Modern Practice of Gas Chromatography* – 3rd Edition
14. Hawthorne, Steven B., & Grabanski, Christopher B. – *High-Performance Liquid Chromatography of Environmental Samples* – 1st Edition
15. Miller, J. M. – *Atomic Spectroscopy* – 2nd Edition
16. Marrison, John W. – *Practical Atomic Absorption Spectroscopy* – 1st Edition
17. Ingle, John D., & Crouch, Stanley R. – *Spectrochemical Analysis* – 2nd Edition
18. Welz, Bernhard, & Sperling, Michael – *Atomic Absorption Spectrometry: A Practical Guide* – 2nd Edition
19. Khopkar, S. M. – *Basic Concepts of Analytical Chemistry* – 3rd Edition (includes flame photometry and AAS)

## M. Sc. Forensic Science Semester - I

### DSE: MFS3P02B: Practical - II

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 02

60 Lectures/Semester

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Understand and apply various chromatographic techniques (paper chromatography, TLC, gas chromatography) for the separation and identification of inorganic and organic compounds.
2. Gain practical skills in using spectrophotometric and flame photometric methods for quantitative analysis of metal ions in different samples.
3. Develop the ability to determine the composition and concentration of components in complex mixtures such as soft drinks, soil, and pharmaceutical tablets.
4. Demonstrate proficiency in handling and analyzing environmental and forensic samples using modern instrumental techniques like AAS and GC.
5. Interpret experimental data accurately and correlate the results with theoretical knowledge to make informed scientific conclusions.

#### List of Practicals (Minimum of 8 have to be completed)

1. Separation and identification of metal ions present in a given mixture using ascending paper chromatography. (2)
2. Investigation and separation of the organic pigments in paint sample by TLC. (2)
3. Determination of ion-exchange capacity of cation exchange resin.
4. Detection of phenolphthalein by thin layer chromatography (TLC).
5. Detection of phenolphthalein by spectrophotometric method.
6. Identification of arson accelerants by gas chromatography.
7. Determination of relative concentrations of different components in gasoline by gas chromatography.
8. Determination of calcium (Ca) in soil samples by flame photometry method.
9. Determination of magnesium (Mg) in soil samples by atomic absorption spectrophotometer (AAS).
10. Determination of potassium (K) in soil samples by flame photometry method.
11. Spectrophotometric Determination of Iron in Vitamin/Dietary Tablets (2)
12. Quantitative determination of iron content of a commercially available vitamin tablet using UV-vis spectrophotometry.
13. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks
14. Measurement of two major species such as caffeine and sodium benzoate in soft drinks using spectrophotometry.

#### Suggested Readings

1. Baselt, R. C. (2020). *Disposition of toxic drugs and chemicals in man* (12th ed.). Biomedical Publications.
2. Clarke, E. G. C. (2011). *Clarke's analysis of drugs and poisons* (4th ed.). Pharmaceutical Press.
3. James, M., Morris, R., & Coyle, H. M. (2013). *Forensic toxicology: Principles and concepts* (2nd ed.). CRC Press.
4. Levine, B. (2019). *Principles of forensic toxicology* (5th ed.). Springer Publishing Company.
5. Sunshine, I. (1992). *Handbook of toxicology* (2nd ed.). CRC Press.
6. Christian, G. D. (2004). *Analytical chemistry* (6th ed.). John Wiley & Sons.
7. Day, R. A., & Underwood, A. L. (1991). *Quantitative analysis* (6th ed.). Prentice Hall.

8. Khopkar, S. M. (1998). *Basic concepts of analytical chemistry* (3rd ed.). New Age International.
9. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of instrumental analysis* (7th ed.). Cengage Learning.
10. Vogel, A. I. (1989). *Textbook of quantitative chemical analysis* (6th ed.). Longman Scientific & Technical.
11. Bassett, J., Denney, R. C., Jeffery, G. H., & Mendham, J. (1978). *Vogel's textbook of quantitative inorganic analysis* (4th ed.). Longman.
12. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). *Inorganic chemistry: Principles of structure and reactivity* (4th ed.). HarperCollins College Publishers.
13. Malik, W. U., & Tuli, G. D. (2009). *Selected topics in inorganic chemistry* (Revised ed.). S. Chand & Company.
14. Puri, B. R., Sharma, L. R., & Kalia, K. C. (2017). *Principles of inorganic chemistry* (33rd ed.). Vishal Publishing Co.
15. Svehla, G. (1996). *Vogel's qualitative inorganic analysis* (7th ed.). Pearson Education.
16. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (1989). *Vogel's practical organic chemistry* (5th ed.). Longman Scientific & Technical.
17. Ghoshal, S., Mahapatra, A. K., & Ghosh, S. (2015). *A textbook of practical chemistry* (Latest ed.). New Central Book Agency.
18. Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. (2000). *Vogel's quantitative chemical analysis* (6th ed.). Prentice Hall.

**Specialization – III**  
**Forensic Biology &**  
**Serology**

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T01C: Forensic Biology and Entomology

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives

1. To introduce students to forensic applications of botany, food, faecal, and entomological evidence in medico-legal investigations.
2. To develop practical competence in the collection, preservation, and interpretation of biological and entomological evidence.

#### Course Outcomes

1. Explain fibre, starch, paper, and pulp analysis methods and their forensic significance.
2. Identify and examine stomach contents, food items, and faecal matter for forensic purposes.
3. Describe the classification, life cycle, and forensic relevance of blowflies and other necrophagous insects.
4. Apply methods for collection, preservation, and analysis of entomological evidence from different environments.
5. Estimate post-mortem interval (PMI) using insect succession and ecological parameters.
6. Demonstrate field and laboratory techniques in forensic entomology with case-based applications.

#### Unit I: Forensic Botany

- Fibre examination- microscopic, temporary mount.
- Maceration of plant fibres, cross-sectioning, physical methods (twist on drying, floatation method, burning test) by using the following examples Cotton, coir, wool, silk, jute.
- Identification of starch grains, powder and stains of spices.
- Paper and Paper Pulp identification, Microscopic and biochemical examination of pulp material.

#### Unit II: Other Biological Evidences

- Examination of stomach contents- microscopic examination.- Identification of Food stuffs & their stains: Plants used as food, animals used as food.
- Examination of plant foods-microscopic and macroscopic examination.
- Examination of animal foods (meat & fish) – microscopic and macroscopic examination.
- Examination of faecal matter & faecal stains: Physical appearance, microscopic examination, urobilinogen test.

#### Unit III: Forensic Entomology-I

- Introduction, history, and development of Forensic Entomology.
- General Classification and life cycle of Blowfly (Diptera).
- Insects of forensic importance.
- Collection of entomological evidence during legal investigations.
- Preservation of Entomological evidences (Soft bodied and Hard bodied Insects).

#### **Unit IV: Forensic Entomology-II**

- Collection of meteorological data, specimens before body removal, ground-crawling arthropods on and around the body.
- Study of successional colonization on body.
- Collection of entomological samples from the body, entomological samples during autopsy.
- Specimens from buried remains from enclosed structures & aquatic habitats. Determination of PMI using entomological evidence.

#### **Suggested Readings:**

1. Esau's Plant Anatomy – Katherine Esau; Wiley.
2. Plant Anatomy – B.P. Pandey; S. Chand Publishing.
3. Forensic Botany: Principles and Applications to Criminal Casework – Heather Miller Coyle; CRC Press.
4. Textbook of Fibre Science and Technology – S.P. Mishra; New Age International Publishers.
5. Forensic Biology – Richard Li; CRC Press.
6. Practical Forensic Microscopy: A Laboratory Manual – Barbara Wheeler & Lori Wilson; Wiley-Blackwell.
7. Food Microbiology – Frazier & Westhoff; McGraw-Hill Education.
8. Food Science – Norman N. Potter & Joseph H. Hotchkiss; Springer.
9. Medical Microbiology – Patrick R. Murray, Ken S. Rosenthal & Michael A. Pfaller; Elsevier.
10. Forensic Entomology: The Utility of Arthropods in Legal Investigations – Jason H. Byrd & James L. Castner; CRC Press.
11. Forensic Entomology: An Introduction – Dorothy Gennard; Wiley-Blackwell.
12. The Science of Forensic Entomology – David B. Rivers & Gregory A. Dahlem; Wiley-Blackwell.
13. A Manual of Forensic Entomology – Kenneth G.V. Smith; Cornell University Press.
14. Medical and Veterinary Entomology – Gary Mullen & Lance Durden; Academic Press (Elsevier).
15. Entomology and Crime: Flies as Forensic Indicators – M. Lee Goff; CRC Press.

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T02C: Forensic Serology

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives

1. To impart knowledge about composition, biochemical and forensic significance of body fluids.
2. To train students in serological techniques and molecular methods for forensic identification.

#### Course Outcomes

1. Describe the composition, abnormal constituents, and forensic importance of major body fluids.
2. Perform presumptive and confirmatory tests for blood, semen, saliva, sweat, urine, and vaginal fluid.
3. Demonstrate serological typing methods including agglutination, absorption-elution, and precipitin tests.
4. Explain the role of biochemical markers and polymorphic enzymes in human identification and paternity testing.
5. Apply sequencing technologies (Sanger, Pyrosequencing, NGS) in forensic DNA analysis.
6. Evaluate the limitations, reliability, and admissibility of serological evidence in forensic analysis.

#### Unit I

- Blood, Urine- composition, Physical and chemical properties, abnormal constituents and clinical significance.
- Amniotic fluid, Saliva- Composition, Physical and chemical properties, abnormal constituents and clinical significance.
- Semen and Vaginal fluid- Physical and chemical properties, composition, abnormal constituents and clinical significance.
- Faeces, Sweat, - Composition, abnormal constituents, Physical and chemical properties, and clinical significance.

#### Unit II

- Physical, Chemical and Confirmatory tests of Blood and blood stains–(TMB, Kastle-Meyer Test, Luminol) (Takayama, Teichmann, Spectrophotometric).
- Semen and seminal stains- (Acid Phosphatase Test, Visual examination using Light), (Microscopic examination) Gram staining, cross-over electrophoresis; Examination of vaginal fluid & stains of vaginal secretions-Physical examination, SAP/VAP electrophoresis, Lugol's stain.
- Examination of saliva & saliva stains- starch-iodine test, salivary haemagglutinin test, radial diffusion test for amylase activity.
- Examination of urine stains- Odour test, urea nitrate crystal test, creatinine test.

### Unit III

- Introduction to Biochemical Markers: forensic significance, characteristics of polymorphic enzymes like PGM, EsD.
- Introduction to Biochemical Markers: forensic significance, characteristics of polymorphic enzymes like AK, ADA.
- Paternity disputes using biochemical markers: Calculation of paternity index
- Probability for paternity and maternity.

### Unit-IV

- Nucleic acid sequencing, Dideoxy sequencing by Sangers method.
- Dye primer chemistry and dye terminator chemistry,
- Pyrosequencing,
- Capillary electrophoresis and fragment analysis.
- Sequencing by synthesis (Illumina), NanoPore sequencing.

### Suggested Readings:

1. Practical Clinical Biochemistry (Vol. 1 & 2) – Harold Varley; CBS Publishers.
2. Textbook of Biochemistry for Medical Students – D.M. Vasudevan & Sreekumari; Jaypee Brothers Medical Publishers.
3. Clinical Biochemistry: Metabolic and Clinical Aspects – William J. Marshall, Márta Lapsley, Andrew Day, & Ruth M. Ayling; Elsevier.
4. Medical Laboratory Science: Theory and Practice – Jean J. Baker; Pearson.
5. Biochemical Genetics: A Laboratory Manual – R.H. Garrett & C.M. Grisham; Waveland Press.
6. Principles of Genetics – D. Peter Snustad & Michael J. Simmons; Wiley.
7. Human Molecular Genetics – Tom Strachan & Andrew Read; Garland Science.
8. Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers – John M. Butler; Elsevier Academic Press.
9. Biochemical Genetics: A Laboratory Manual – R.H. Garrett & C.M. Grisham; Waveland Press.
10. Principles of Genetics – D. Peter Snustad & Michael J. Simmons; Wiley.
11. Human Molecular Genetics – Tom Strachan & Andrew Read; Garland Science.
12. Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers – John M. Butler; Elsevier Academic Press.
13. Molecular Biology of the Gene – James D. Watson et al.; Pearson.
14. Molecular Cloning: A Laboratory Manual – Joseph Sambrook & David W. Russell; Cold Spring Harbor Laboratory Press.
15. DNA Sequencing: A Short Course – Leroy Hood & David Galas; Cold Spring Harbor Laboratory Press.
16. Next-Generation DNA Sequencing Informatics – Stuart M. Brown; Cold Spring Harbor Laboratory Press.

**M. Sc. Forensic Science Semester - III**  
**DSC: MFS3T03C: DNA Fingerprinting**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives**

1. To provide theoretical and practical knowledge of DNA/RNA extraction, quantification, amplification, and profiling.
2. To train students in advanced DNA typing methods for human and non-human forensic investigations.

**Course Outcomes**

1. Demonstrate techniques for DNA and RNA extraction, quantification, and purity analysis.
2. Apply different PCR techniques (Nested, RT-PCR, Multiplex, Touchdown) and optimize reactions.
3. Analyze STRs, mini-STRs, and SNPs in forensic DNA profiling and database development.
4. Evaluate challenges in degraded DNA, low copy number samples, and contaminated evidence.
5. Describe non-human and wildlife DNA testing including species identification and biodiversity monitoring.
6. Critically assess advancements such as microarrays, synthetic DNA, and next-generation sequencing for forensic applications.

**Unit I**

- Sample collection and preservation of DNA from various sources.
- DNA extraction method- Solid phase DNA extraction methods, DNA extraction using Qiagen kits. DNA quantification- Slot blot assay, Pico-green microtiter plate assay.
- Methods of RNA Extraction- RNA-DNA Coextraction and miRNA (Micro RNA) Extraction.
- Aluquant human DNA quantification system, Determining the quantity and purity of nucleic acids by using UV spectrophotometry.

**Unit II**

- DNA Amplification- Basic PCR cycle, Components of PCR.
- Factors affecting PCR, Optimization of PCR assay.
- Types of PCR- Nested PCR, Touchdown PCR, Gradient PCR, Hot-starts PCR, RT-PCR, multiplex PCR, endpoint PCR.
- PCR inhibitors and solutions, Contamination Issues,

**Unit III**

- Status of development of DNA profiling in India & abroad- Current Perspective and Future Challenges in India.
- Population databases of DNA markers –STRs, Mini STRs, SNPs, Basics of STR typing, Uses of STR Typing.
- New & future technologies: Microarrays technology, Synthetic DNA.
- Analysis of Degraded DNA, Low Copy Number DNA,

## Unit IV

- Non-human DNA testing: Sources, domestic animal DNA testing (cat DNA, dog DNA).
- Canine STR Loci and assays, Canine mtDNA Testing, species identification: (mtDNA cytochrome b gene, mtDNA 12S rRNA gene, mtDNA COI gene).
- Wildlife DNA testing, Techniques for Assessing Genetic Differences (DNA Sequencing, STR Typing, RAPD, AFLP, T-RFLP).
- Genetic markers for Wildlife DNA Profiling (Measuring Genetic Variation, Microsatellites, SNPs, DNA Profiles, Validation of DNA Profiling Markers).

## Suggested Readings:

1. Molecular Cloning: A Laboratory Manual – Joseph Sambrook & David W. Russell; Cold Spring Harbor Laboratory Press.
2. Molecular Biology of the Cell – Bruce Alberts et al.; Garland Science.
3. Molecular Biology: Principles and Practice – Michael M. Cox, Jennifer Doudna & Michael O'Donnell; W.H. Freeman.
4. Molecular Diagnostics: Fundamentals, Methods and Clinical Applications – Lela Buckingham & Maribeth Flaws; F.A. Davis Company.
5. PCR Protocols: A Guide to Methods and Applications – Michael A. Innis, David H. Gelfand, John J. Sninsky, & Thomas J. White; Academic Press.
6. Polymerase Chain Reaction: Current Innovations and Future Trends – Patricia Hernandez-Rodriguez & Andrea Krüger; Caister Academic Press.
7. PCR Technology: Current Innovations – Tania Nolan & Stephen A. Bustin; CRC Press.
8. Quantitative PCR Protocols – Stephen A. Bustin; Humana Press (Springer).
9. Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers – John M. Butler; Elsevier Academic Press.
10. Advanced Topics in Forensic DNA Typing: Interpretation – John M. Butler; Academic Press.
11. An Introduction to Genetic Analysis – Anthony J.F. Griffiths et al.; W.H. Freeman.
12. Fundamentals of Forensic DNA Typing – John M. Butler; Academic Press.
13. Wildlife DNA Analysis: Applications in Forensic Science – Adrian Linacre & Shanan Tobe; Wiley-Blackwell.
14. Forensic DNA Applications: An Interdisciplinary Perspective – Dragan Primorac & Moses Schanfield; CRC Press.
15. Genetic Data Analysis for Plant and Animal Breeding – Fikret Isik, James Holland, & Christian Maltecca; Springer.
16. Molecular Markers, Natural History and Evolution – J.C. Avise; Chapman & Hall.

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3T04C: Microbial Forensics**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives**

1. To familiarize students with epidemiology, disease outbreak investigations, and microbial toxins in forensic contexts.
2. To train students in molecular and instrumental methods for microbial identification in forensic analysis.

**Course Outcomes**

1. Explain principles of epidemiology, outbreak investigation, and the role of surveillance in forensic microbiology.
2. Discuss deliberate introduction of biological agents and their forensic implications.
3. Identify biological toxins (Clostridial, staphylococcal, aflatoxins, ricin) and describe their mechanisms and clinical effects.
4. Apply instrumental methods (SEM, AFM, Raman spectroscopy, Mass spectrometry) for biological signatures.
5. Demonstrate molecular typing methods such as DGGE, TGGE, ARDRA, RAPD, AFLP, and RFLP.
6. Evaluate emerging microbial forensic technologies for attribution and bioterrorism investigations.

**Unit I: Forensic Microbiology: Epidemiologic Investigation**

- Dynamics of disease transmission, outbreak investigation and Composition of an outbreak investigation team.
- Deliberate introduction of a biological agent,
- Investigation of suspicious disease outbreaks: natural and deliberate disease, Importance of disease surveillance.
- Specimen collection, environmental sampling, sample handling, specimen storage, laboratory analysis.

**Unit II: Forensic Aspects of Biological Toxins:**

- Classification of Biological toxins.
- Clostridial bacteriology, Neurotoxin structure and mode of action. Staphylococcal enterotoxin b, mode of action, Clinical signs and symptoms.
- Aflatoxin structure and function, mode of action, clinical signs and symptoms.
- Ricin structure and function, mode of action, clinical signs and symptoms.

**Unit III: Non-DNA Methods for Biological Signatures**

Introduction, Principle and applications of:

- Scanning electron microscopy
- Atomic force microscopy
- Raman spectroscopy
- Mass spectrometry

#### **Unit IV: Emerging Microbial Forensic Techniques**

- Polymerase Chain Reaction, Thermal and Denaturing Gradient Gel Electrophoresis (TGGE, DGGE),
- Terminal Restriction Fragment Length Polymorphism (TRFLP), Amplified Fragment Length Polymorphism (AFLP), Single Stranded Conformation Polymorphism Analysis (SSCP).
- Amplified Ribosomal DNA Restriction Analysis (ARDRA), Randomly Amplified Polymorphic DNA (RAPD);
- Non-PCR DNA Fingerprinting Techniques with Applicability in Forensic Studies- Restriction Fragment Length Polymorphisms (RFLP)

#### **Suggested Readings:**

1. Forensic Microbiology – David O. Carter; Wiley-Blackwell.
2. Microbial Forensics – Bruce Budowle, Steven E. Schutzer, Roger G. Breeze; Academic Press (Elsevier).
3. Infectious Disease Epidemiology: Theory and Practice – Kenrad E. Nelson & Carolyn Masters Williams; Jones & Bartlett Learning.
4. Medical Microbiology – Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller; Elsevier.
5. Epidemiology: An Introduction – Kenneth J. Rothman; Oxford University Press.
6. Medical Microbiology and Immunology – Warren Levinson; McGraw-Hill.
7. Bacterial Pathogenesis: A Molecular Approach – Abigail A. Salyers & Dixie D. Whitt; ASM Press.
8. Molecular Medical Microbiology (3 Vols.) – Yi-Wei Tang, Max Sussman, Dongyou Liu; Academic Press.
9. Handbook of Toxicology of Chemical Warfare Agents – Ramesh Gupta; Academic Press.
10. Plant Toxins – P.G. Coleman; Springer.
11. Scanning Electron Microscopy and X-Ray Microanalysis – Joseph Goldstein et al.; Springer.
12. Atomic Force Microscopy in Biomedical Research – Pier Carlo Braga & Davide Ricci; Springer.
13. Introduction to Raman Spectroscopy – John R. Ferraro, Kazuo Nakamoto, Chris W. Brown; Academic Press.
14. Mass Spectrometry: Principles and Applications – Edmond de Hoffmann & Vincent Stroobant; Wiley.
15. Principles of Instrumental Analysis – Douglas A. Skoog, F.J. Holler & Stanley Crouch; Cengage Learning.
16. PCR Protocols: A Guide to Methods and Applications – Michael A. Innis, David H. Gelfand, John J. Sninsky & Thomas J. White; Academic Press.
17. Molecular Cloning: A Laboratory Manual – Joseph Sambrook & David W. Russell; Cold Spring Harbor Laboratory Press.
18. Molecular Microbiology: Diagnostic Principles and Practice – David H. Persing; ASM Press.
19. Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers – John M. Butler; Academic Press.
20. Molecular Forensics: Methods and Protocols – Ralph Rapley; Humana Press (Springer).

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3P01C: Practical - I**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 04**

**120 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Understand and apply techniques for microscopic and chemical examination of biological and fibrous materials such as fibers, wood, and paper.
2. Perform preliminary and confirmatory tests for biological fluids including blood, semen, and saliva, and interpret forensic significance.
3. Demonstrate the ability to extract, quantify, and analyze DNA from various biological sources using molecular biology tools like PCR and UV spectroscopy.
4. Analyze entomological and serological evidence to estimate post-mortem interval and identify species origin in forensic investigations.
5. Gain practical exposure through field visits to forensic and biological research facilities, enhancing understanding of real-world applications.

**List of Practicals (Minimum of 12 have to be completed)**

1. Examination of fiber (cotton, silk, wool, jute, rayon, nylon, asbestos etc.)
2. Microscopic examination of wood, pulp, paper.
3. Examination of plant and animal foods.
4. Estimation of time since death from entomological evidences.
5. Preliminary examination and confirmatory tests of blood.
6. Preliminary examination and confirmatory tests of semen.
7. Preliminary examination and confirmatory tests of saliva by Starch-iodide test.
8. Identification of origin of species (precipitin test)
9. ABO blood grouping from other body fluids
10. Determination of purity and quantity of DNA.
11. Extraction of genomic DNA from microorganisms.
12. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
13. To perform the PCR amplification using extracted DNA (various biological sources).
14. Visit to autopsy center at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Center, Biodiversity and wildlife Center.

## M. Sc. Forensic Science Semester - III

### DSE: MFS3T05C: Techniques in Forensic Biology

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives

- To provide knowledge of instrumental and analytical techniques for the study of biological evidence.
- To develop expertise in nanotechnology and its applications in forensic science.

#### Course Outcomes

- Apply chromatographic (TLC, HPLC, GC) and spectroscopic (UV-Vis, IR, NMR) techniques in forensic biology.
- Perform electrophoresis (Agarose, PAGE, Isoenzyme) and blotting techniques for biomolecule analysis.
- Demonstrate centrifugation methods for separation of nucleic acids, proteins, and cell components.
- Characterize nanomaterials using microscopic and spectroscopic methods.
- Explain physical, chemical, and biological methods of nanomaterial synthesis.
- Evaluate applications of nanotechnology in forensic investigations including trace evidence analysis and biosensors.

#### Unit I: Chromatography

Principle, working, and applications of

- Planar chromatography (Paper, TLC and HPTLC),
- Column Chromatography (HPLC and GC),
- Ion exchange Chromatography,
- Affinity Chromatography,
- Principle and applications of Hyphenated techniques (HPLC-MS, GC-MS)

#### Unit II: Spectroscopy

Principle, working and applications of

- Ultra-violet and visible spectrophotometer
- Infrared spectrophotometer
- Atomic absorption spectrometer
- Raman Spectrophotometer
- Fluorescence spectrophotometer

#### Unit III: Electrophoresis and Centrifugation

General principles and applications of

- Agarose Gel Electrophoresis
- Polyacrylamide Gel Electrophoresis (Native-PAGE and SDS-PAGE)
- Capillary Electrophoresis;
- Iso-electric focusing (IEF)
- Blotting techniques: Southern Blotting; Northern Blotting; Western Blotting.
- General Principles of Centrifugation (Sedimentation velocity and sedimentation equilibrium).

## Unit IV: Nanotechnology

- Nanomaterials (Nanoclusters, Solid solutions, Thin film, Nanocomposites);
- Mechanical-physical-chemical properties of Nanomaterials;
- Synthesis of Nanomaterials- Physical methods- (Physical vapour deposition-PVD; Electric Arc discharge; Ball Milling); Chemical Methods- (Sol-gel method, Solvothermal, Chemical Vapor Deposition-CVD); Biological Methods- (Plant and microorganisms- Bacteria and Algae);
- Characterization of nanomaterials- Microscopic (TEM, SEM) and Spectroscopic (UV-VIS, Raman spectroscopy) analysis.
- Applications of Nanotechnology in Forensic Science.

### Suggested readings:

1. Principles and Techniques of Biochemistry and Molecular Biology: Edt. Keith Wilson, John Walker
2. Biophysical chemistry Principles and techniques: Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath.
3. Instrumental Methods of Analysis 6th Edition. (1986): H.H. Willard, L.L. Merritt Jr. and others. CBS Publishers and Distributors.
4. Instrumental Methods of Chemical Analysis. (1989): Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.
5. A Biologists Guide to Principles and Techniques of Practical Biochemistry. (1975): Williams, B.L. and Wilson, K.
6. Spectroscopy. (Vol. 1): Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
7. Gel Electrophoresis of Proteins- A Practical Approach: Hanes.
8. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
9. "Introduction to Biophysical Chemistry" by Prof. Sudhakar Banerjee and Prof. Rama Debata.
10. "Biophysical Chemistry: A Conceptual Approach" by Prof. Rajendra Nath and Prof. G.N. Saibaba.
11. "Biophysical Chemistry" by Prof. M.M. Chaturvedi and Dr. Surendra Kumar.
12. Analytical Biochemistry: Holme.
13. Introduction to High Performance Liquid Chromatography: R. J. Hamilton and P. A. Sewell.
14. Spectroscopy: B.P. Straughan and S. Walker.
15. Practical aspects of Gas Chromatography and Mass Spectrometry (1984) by Gordon M. Message, John Wiley and Sons, New York.
16. Gel Chromatography by Tibor Kremmery.
17. Nanostructures and Nanomaterials: Synthesis, Properties and Applications – Guozhong Cao & Ying Wang; World Scientific Publishing.
18. Nanotechnology: Principles and Practices – Sulabha K. Kulkarni; Springer.
19. Characterization of Nanostructures – S. Kumar & R. Nagarajan; Springer.
20. Nanotechnology in Forensic Science: Applications and Techniques – Chaudhery Mustansar Hussain & Ashutosh Kumar; Wiley-Scrivener.
21. Nanodentistry: Novel Approaches, Chapter 24, Nehi Sinha, Niha M. Kulshreshtha, Meenal Dixit, Indrani Jadhav, Divya Shrivastava, Prakash S. Bisen
22. Essentials In Nanoscience And Nanotechnology, Narendra Kumar, Sunita Kumbhat
23. Nonequilibrium Flow-Synthesis of Solid-Solution Alloy Nanoparticles: From Immiscible Binary to High-Entropy Alloys
24. Handbook of sputter deposition technology [recurso -- Hideaki Adachi; Kiyotaka Wasa; Isaku Kanno; Hidetoshi Kotera -- 2nd ed, Amsterdam, 2012

25. Chapter-Nanocomposite Materials by Mousumi Sen
26. Principles Of Nanoscience And Nanotechnology, Dr. A. B. K. Rajan, Dr. C. Dhavamani
27. Chapter-2, Physical and chemical properties of nanomaterials, Sarita P. Patil, Vishal V. Burungale
28. Nanochemistry Synthesis, Characterization and Applications By- Ashutosh Sharma
29. A Laboratory Course in Nanoscience and Nanotechnology by Dr. G errard Eddy Jai Poinern
30. Handbook of Analytical Techniques for Forensic Samples\_ Current and Emerging Developmentsby Chaudhery Mustansar Hussain\_ Deepak Rawtani\_ Gaurav Pandey\_ Maithri Tharmavaram - -Elsevier (2020)
31. Amretashis Sengupta, Chandan Kumar Sarkar Editors Introduction to Nano Basics to Nanoscience and Nanotechnology
32. Microscopic Techniques for Nanomaterials Characterization: A Concise Review-Abbas Aziz, Huma Shaikh, Amna Abbas, Kissa E. Zehra, Bakhtawar Javed
33. Nanomaterials and Nanocomposites Synthesis, Properties, Characterization Techniques, and Applications by Rajendra Kumar Goyal
34. Nanotechnology in Forensic Science, Ian Turner, Article · September 2010 <https://www.researchgate.net/publication/305441732>
35. Applications of Nanotechnology in Forensic Investigation Vivek Chauhan<sup>1</sup>, Vandana Singh<sup>1</sup>, Archana Tiwari Int. J. Life. Sci. Scienti. Res., 3(3): 1047-1051 MAY 2017
36. Nanotechnology and Its Uses in Forensic Science, Prashant Kumar and Paromita Banerjee
37. Handbook of Analytical Techniques for Forensic Samples\_ Current and Emerging Developmentsby Chaudhery Mustansar Hussain\_ Deepak Rawtani\_ Gaurav Pandey\_ Maithri Tharmavaram - -Elsevier (2020)

**M. Sc. Forensic Science Semester - I**

**DSE: MFS3P02C: Practical - II**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02**

**60 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Perform DNA and protein separation techniques such as agarose gel electrophoresis, SDS-PAGE, and native electrophoresis for forensic and biomedical analysis.
2. Extract, isolate, and characterize genomic and plasmid DNA from microorganisms for molecular investigations.
3. Analyze plant-based poisons and metabolites using chromatographic techniques like planar and column chromatography.
4. Synthesize and characterize metal nanoparticles using both chemical and biological methods, including spectroscopic analysis.
5. Understand the principles and procedures of blotting techniques (Southern and Western) and apply them in forensic and biochemical research.

**List of Practicals (Minimum of 8 have to be completed)**

1. Agarose Gel electrophoresis of DNA.
2. Extraction and separation of genomic from microorganisms.
3. Extraction and separation of plasmid DNA from microorganisms.
4. Native Electrophoresis of Serum proteins.
5. Separation of serum enzymes using SDS-PAGE.
6. Separation of plant poisons by planar chromatography.
7. Extraction and isolation of plant metabolites using column chromatography.
8. Synthesis of metal nano-particles using chemical synthesis.
9. Synthesis of metal nanoparticles using biological synthesis.
10. Spectroscopic characterization of nanoparticles.
11. To perform Southern blotting.
12. To perform Western blotting.
13. Spectrophotometric analysis of dispersible tablets (Paracetamol, dispirin, etc).
14. Visit to autopsy center at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Center, Biodiversity and wildlife Center.

**Specialization – IV**  
**Digital & Cyber**  
**Forensic**

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3T01D: File System**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives:**

1. To provide a comprehensive understanding of different file system architectures including FAT, NTFS, Ext2/Ext3, and UFS1/UFS2.
2. To analyze and interpret the internal data structures and metadata used by various file systems.
3. To develop practical skills for performing forensic and structural analysis of file systems.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Identify and explain the structural components of major file systems such as FAT32, NTFS, Ext2/Ext3, and UFS1/UFS2.
2. Analyze file system categories including content, metadata, file names, and boot structures.
3. Interpret directory entries, file attributes, and special structures like MFT entries and FSINFO.
4. Utilize appropriate tools to extract and examine file system data for forensic or diagnostic purposes.
5. Compare and contrast different file system designs and their impact on performance, reliability, and recoverability.

**Unit I: FAT Concepts, Data Structures and Analysis**

Introduction, File System Category, Content Category, Metadata Category, File Name Category, Boot Sector, FAT32 FSINFO, FAT, Directory Entries, Long File Name Directory Entries, FAT Data Structures.

**Unit II: NTFS Concepts, Data Structures and Analysis**

Introduction, Everything is a File, MFT Concepts, MFT Entry Attribute Concepts, Other Attribute Concepts, Indexes, Analysis Tools, and Analysis: File System Category, Content Category, Metadata Category, File Name Category, Application Category, and NTFS Data Structures

**Unit III: Ext2 and Ext3 Concepts, Data Structure and Analysis**

Introduction, File System Category, Content Category, Metadata Category, File Name Category, Application Category, The Big Picture, Ext2 and Ext3 Data Structure.

**Unit IV: UFS1 and UFS2 Concepts, Data Structure and Analysis**

Introduction, File System Category, Content Category, Metadata Category, File Name Category, The Big Picture, UFS1 and UFS2 Data Structures.

**Suggested Readings:**

1. File system forensic analysis by Brian Carrier

**M. Sc. Forensic Science Semester - III**  
**DSC: MFS3T02D: Digital Image Processing**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives:**

1. To introduce the fundamental concepts and techniques used in digital image processing.
2. To explore various methods of image enhancement, restoration, and compression in both spatial and frequency domains.
3. To develop the ability to apply theoretical knowledge to practical image processing problems and tools.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Understand the basic components and steps involved in digital image processing systems.
2. Apply techniques for image enhancement in both spatial and frequency domains.
3. Analyze and implement noise reduction and restoration techniques for degraded images.
4. Explain and utilize different image compression techniques including error-free and lossy compression.
5. Interpret the role of visual perception, sensing, and quantization in the image processing pipeline.

**Unit I**

Introduction, Fundamental Steps in Digital Image Processing, Components of An Image Processing System, Elements of Visual Perception, Light and The Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationship Between Pixels

**Unit II**

**Image Enhancement in Spatial Domain:** Basic Gray Level Transformation, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters

**Unit III**

**Image Enhancement in Frequency Domain:** Introduction to Fourier Transform and The Frequency Domain, Smoothing Frequency Domain Filters, Sharpening Frequency Domain Filters.

**Image Restoration:** Introduction, Noise Models, Restoration in Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering

**Unit IV**

**Image Compression:** Fundamentals, Image Compression Models, Error Free compression, Lossy Compression, Image Compression Standards

**Suggested Readings:**

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing (2nd Edition)", Prentice-Hall, Inc., USA
2. Anil K. Jain, "Fundamentals of Digital Image Processing", PHI
3. B. Chanda, Dutta Majumdar, "Digital Image Processing and Analysis", PHI

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3T03D: Network Forensics**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives:**

1. To introduce the core principles, models, and challenges of network forensics and its role in cybersecurity.
2. To explore various tools, techniques, and frameworks used for network forensic acquisition, analysis, and attribution.
3. To examine advanced topics such as botnet forensics and cloud forensics with a focus on current research and practical applications.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Understand the fundamentals, classifications, and challenges of network forensics.
2. Apply different forensic process models and frameworks for conducting network investigations.
3. Use appropriate tools for packet capture, analysis, and network monitoring.
4. Analyze network data for detecting misuse, anomalies, and identifying attack sources.
5. Evaluate and apply forensic techniques in complex environments such as botnets and cloud infrastructures.

**Unit I**

**Fundamentals of network forensics:** Introduction, Definition, Classification of network forensics, Challenges in network forensics

**Network forensic process model:** Digital Forensic process model, Hierarchical process model, Network Forensic process model

**Network Forensic Frameworks:** Distributed system –based framework, Honeynet-based Framework

**Network Forensic Tools:** Network Sniffing and Packet Analysis Tools, Network Scanning and monitoring tools

**Unit II**

**Network Forensic Acquisition:** TCP/ IP Protocol Suite, Packet Capture Format, Pcapng dump File Format, Netflow Record Format

**Network Forensic Analysis:** Misuse Detection, Anomaly Detection

**Network Forensic Attribution:** Probabilistic packet marking, Deterministic packet marking

**Unit III**

**Botnet Forensics:** Introduction, Acquisition, Analysis, Attribution, Research challenges

**Unit IV**

**Cloud Forensics:** Definition, Generic Process Model, Investigation of Cloud Infrastructure, Cloud forensic attribution, Investigation using VMI in cloud environment, Cloud forensic challenges

**Suggested Readings:**

1. Fundamentals of Network Forensics- A Research Perspective Authors: Joshi, R.C., Pilli, Emmanuel S. Springer
2. Introduction to Security and Network Forensics by William J. Buchanan
3. Digital Forensics and Incident Response: A practical guide to deploying digital forensic techniques in response to cyber security incidents by Gerard Johansen
4. Network Forensic by Ric Messier

**M. Sc. Forensic Science Semester - III**  
**DSC: MFS3T04D: Applied Cryptography**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives:**

1. To provide a strong foundation in number theory concepts essential for modern cryptography.
2. To introduce symmetric and asymmetric cryptographic algorithms and their security implications.
3. To explore cryptographic primitives, side-channel attacks, and real-world applications like key exchange protocols and blockchain.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Apply number theory concepts such as modular arithmetic and GCD in cryptographic algorithms.
2. Understand and compare symmetric block ciphers like DES, AES, and their variants.
3. Explain and implement public key cryptosystems including RSA, ElGamal, Diffie-Hellman, and ECC.
4. Evaluate the security properties of hash functions and message authentication codes.
5. Analyze side-channel vulnerabilities and understand the practical applications of cryptography in protocols and blockchain systems.

**Unit I**

**Number Theory Basics:** Modular arithmetic, primes, GCD and Chinese remainder theorems.

**Unit II**

**Block Ciphers:** DES, AES, Double and triple encryptions.

**Public Key Cryptography:** RSA, ElGamal, Diffie-Hellman Key exchange, ECC

**Unit III**

**Hash Functions:** oneway, collision resistant, preimage resistant Hash functions

**Message Authentication Codes:** MAC from Hash functions, MAC from block ciphers.

**Unit IV**

**Side Channel Analysis:** Power / timing analysis of crypto-implementations

**Applications:** Key Establishment Protocols, Blockchain, etc.

**Suggested Readings:**

1. "Cryptography and Network Security: Principles and Practices", Sixth Edition, by William Stallings (Indian Edition)
2. "Handbook of Applied Cryptography", Fifth Printing, by Alfred J. Menezes, Paul C. van Oorschot, and Scott A. Vanstone, CRC Press (Available Online)
3. "Hardware Security : Design, Threats, and Safeguards", by Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, CRC Press, Taylor and Francis Group

## M. Sc. Forensic Science Semester - III

### DSC: MFS3P01D: Practical - I

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 04

120 Lectures/Semester

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Configure and use firewalls, intrusion detection systems, and honeypots to detect, log, and respond to suspicious activity in a controlled lab environment.
2. Analyze common malware types (keyloggers, trojans, backdoors) and apply safe, non-destructive methods to observe behavior and identify indicators of compromise.
3. Capture and interpret network traffic using packet sniffers and Wireshark; perform service and port discovery with Nmap for authorized security assessments.
4. Demonstrate understanding of memory- and input-based vulnerabilities (buffer overflows, format string flaws) and implement coding and configuration mitigations to reduce risk.
5. Conduct authorized password strength assessments and controlled password-cracking exercises, and apply proper cryptographic/password-storage techniques and countermeasures.

#### List of Practicals (Minimum of 12 have to be completed)

1. Firewalls , Intrusion Detection and Honeypots
2. Malware – Keylogger, Trojans, Keylogger countermeasures
3. Understanding Data Packet Sniffers
4. Understanding the buffer overflow and format string attacks
5. Using NMAP for ports monitoring
6. Working with Trojans, Backdoors and sniffer for monitoring network communication
7. Denial of Service and Session Hijacking using Tear Drop, DDOS attack.
8. Implementing Web Data Extractor and Web site watcher.
9. Lan Scanner using look@LAN, wireshark.
10. Understanding DoS Attack Tools- Jolt2, Bubonic, Land and LaTierra, Targa, Nemesy Blast, Panther2, Crazy Pinger, Sometrouble, UDP Flood, FSMax.
11. Email header and URL analysis
12. Drive and partition carving process
13. Password encryption techniques
14. Password strength assessment
15. Password guessing and Password Cracking.

#### Suggested Readings

1. Network Forensics: Tracking Hackers through Cyberspace – Sherri Davidoff, Jonathan Ham
2. File System Forensic Analysis – Brian Carrier
3. Cryptography and Network Security: Principles and Practice – William Stallings
4. Digital Image Forensics: There is More to a Picture than Meets the Eye – Husrev Taha Sencar, Nasir Memon
5. Digital Forensics and Incident Response – Gerard Johansen

## M. Sc. Forensic Science Semester - III

### DSE: MFS3T05D: Image Forensics

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives:

1. To introduce the fundamental concepts of digital image forensics and threats to the integrity of digital media.
2. To explore various techniques for camera source identification and forgery detection in digital images.
3. To examine counter-forensic techniques and their implications on forensic analysis and digital content security.

#### Course Outcomes: On successful completion of this course, students will be able to:

1. Understand threats to digital media integrity and methods of digital content protection.
2. Describe the components of digital cameras and apply frameworks for source camera identification.
3. Detect copy-move forgeries using statistical and block-based image analysis techniques.
4. Identify and classify various counter-forensic techniques used to obscure forensic traces.
5. Analyze the relationship between image forensics, counter-forensics, and other fields in information hiding.

#### Unit I

Threats to the Integrity of Digital Media Content, Digital Content Protection, History of Image Forensic, Introduction to Digital Image Forensic

#### Unit II

**Camera Source Identification:** Introduction, Digital Camera Components, Source Camera Identification Framework

#### Unit III

**Copy-Move Forgery Detection in Digital Images:** Introduction Classification of Block-Based Copy-Move Forgery Detection Techniques, Region Duplication Detection Technique Using, Statistical Image Features

#### Unit IV

**Counter-Forensics:** Definition, Practical Considerations, Classification of Counter-Forensic Techniques, Selected Targeted Attacks, Relation of image forensics and counter-forensics to other fields in information hiding

#### Suggested Readings:

1. Aniket Roy, Rahul Dixit, Ruchira Naskar, Rajat Subhra Chakraborty, "Digital Image Forensics: Theory and Implementation" Springer 2020, ISBN 978-981-10-7643-5
2. Husrev Taha Sencar, Nasir Memon, "Digital Image Forensics: There is More to a Picture than Meets the Eye" Springer 2013, ISBN 978-1-4614-0756-0

**M. Sc. Forensic Science Semester - I**

**DSE: MFS3P02D: Practical - II**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02**

**60 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Identify and explain characteristics of common image formats (.jpg, .jpeg, .png, .bmp) and extract/analyze EXIF metadata.
2. Interpret JPEG quantization tables and apply that knowledge to forensic tasks such as quality assessment and tamper detection.
3. Compare and select appropriate image forensic tools (for example Amped, ImageX) based on investigative requirements and produce reasoned tool-evaluation reports.
4. Demonstrate practical techniques for copy-move forgery detection, vehicle number-plate restoration, and CCTV image/frame restoration using standard forensic workflows.
5. Perform image source identification (camera, scanner, CGI) and platform attribution (WhatsApp, Facebook, Instagram), and recognize basic counter-forensic artifacts including signs of deepfake manipulation.

**List of Practicals (Minimum of 8 have to be completed)**

1. Understanding of Image file formats like .jpg, .jpeg, .png, .bmp etc
2. Understanding of EXIF file and its analysis.
3. Comparison of Image Forensic Tools like Amped, ImageX etc
4. Understanding the concept of Quantization table and its applications
5. Demonstration of Copy-Move forgery detection.
6. Demonstration of Vehicle Number plate restoration
7. Demonstration of CCTV footage image restoration
8. Demonstration of Image Source Identification (Like Camera / Scanner / Computer Generated Image)
9. Demonstration of Image source social network site identification (Like WhatsApp / Facebook / Instagram etc)
10. Understanding the Concept of Counter forensic like Deepfake images.

**Suggested Readings**

1. Digital Image Forensics: There is More to a Picture than Meets the Eye – Husrev Taha Sencar, Nasir Memon
2. Handbook of Digital Forensics of Multimedia Data and Devices – Anthony T. S. Ho, Shujun Li
3. Practical Image and Video Forensics – Natalia Zamboni, Stefano Tubaro
4. Image Processing and Analysis: Variational, PDE, Wavelet, and Stochastic Methods – Tony F. Chan, Jianhong Shen
5. Digital Image Processing – Rafael C. Gonzalez, Richard E. Woods

**Specialization – V**  
**Forensic Physics &**  
**Ballistics**

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3T01E: Spectroscopy - I**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives**

1. To provide fundamental knowledge of UV-Visible, Fluorescence, IR, and Raman spectroscopic techniques.
2. To understand the principles, instrumentation, and applications of different spectroscopic methods in analytical sciences.

**Course Outcomes**

1. Students will gain the ability to explain the principles behind major spectroscopic techniques.
2. They will learn the working and design of instruments used in UV-Visible, Fluorescence, IR, and Raman spectroscopy.
3. They will be able to compare different spectroscopic methods for qualitative and quantitative analysis.
4. Students will develop skills to apply spectroscopy for solving problems in physics, and forensic sciences.

**Unit I:**

**UV-Visible Spectroscopy:** Principle of Production of UV-visible radiation, Sources of UV-Visible radiation, Characteristics and Types of Detectors used in UV-Visible Spectroscopy, Instrumentation for UV-Visible Spectrophotometer – Single Beam and Double Beam, applications of UV-Visible Spectroscopy.

**Unit II:**

**Fluorescence Spectroscopy:** Principle and theory of Luminescence, Fluorescence and Phosphorescence, Fluorescence from Organic and Inorganic systems, Sources of Radiation, Instrumentation for Spectrophotometer, applications of Fluorescence Spectroscopy.

**Unit III:**

**IR Spectroscopy:** Sources of IR radiation, Principle of Production of IR radiation, Characteristics and Types of Detectors used in IR Spectroscopy, Instrumentation for IR Spectrophotometer – Dispersive and Fourier Transform, applications of IR Spectroscopy.

**Unit IV:**

**Raman Spectroscopy:** Principle and theory of Raman spectroscopy, Instrumentation for Raman Spectrophotometer, Comparison of IR and Raman spectroscopy, applications of Raman Spectroscopy.

**Suggested Readings**

1. Principles of Instrumental Analysis – Skoog, Holler, Crouch
2. Instrumental Methods of Analysis – Willard, Merritt, Dean, Settle
3. Introduction to Spectroscopy – Pavia, Lampman, Kriz
4. Spectroscopy of Organic Compounds – P.S. Kalsi
5. Fundamentals of Molecular Spectroscopy – C.N. Banwell, E.M. McCash
6. Modern Spectroscopy – J. Michael Hollas
7. Organic Spectroscopy – William Kemp
8. Physical Methods in Chemistry – R.S. Drago
9. Analytical Chemistry: Principles and Techniques – Larry Christian
10. Infrared and Raman Spectroscopy – Norman Colthup, Lawrence Daly, Stephen Wiberley

## M. Sc. Forensic Science Semester - III

DSC: MFS3T02E: X-rays

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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### Course Objectives

1. To provide knowledge of the fundamental principles of X-ray production, absorption, diffraction, and fluorescence.
2. To understand the instrumentation and analytical applications of X-ray based techniques in materials and chemical sciences.

### Course Outcomes

1. Students will be able to explain the generation and characteristics of X-rays, including continuous and characteristic spectra.
2. They will learn the mechanisms of X-ray absorption, emission, fluorescence, and related phenomena.
3. They will acquire knowledge of XRD methods such as Laue, rotating crystal, and powder methods for structural analysis.
4. Students will be able to apply XRF, photoelectron spectroscopy, and Auger electron spectroscopy for material characterization.
5. They will develop the ability to select suitable X-ray techniques for practical analytical and research applications.

#### Unit I:

**Production of X-rays:** Principle of X-ray production, Types of X-ray spectra – Continuous and Characteristic, Types of X-ray tubes, principle and Production of Synchrotron radiation.

#### Unit II:

**Absorption of X-rays:** Principle and physical process of X-ray absorption, Measurement of X-ray absorption coefficients, Principle of X-ray diffraction, X-ray fluorescence, Auger effect, X-ray emission and absorption spectra.

#### Unit III:

**XRD:** Energy Dispersive X-ray Analysis (EDX), wavelength Dispersive X-ray analysis (WDX), Techniques used for XRD – Laue's method, Rotating crystal method, Powder (Debye-Scherrer) method, Applications of XRD.

#### Unit IV:

**XRF:** Techniques and applications of X-ray fluorescence, Photoelectron spectroscopy and Auger electron spectroscopy.

### Suggested Readings

1. Elements of X-ray Diffraction – B.D. Cullity, S.R. Stock
2. Fundamentals of Crystallography – C. Giacovazzo
3. Principles of X-ray Crystallography – L.S. Denton
4. X-ray Diffraction – B.E. Warren
5. Introduction to Solid State Physics – C. Kittel
6. X-ray Absorption: Principles, Applications, Techniques – D.C. Koningsberger, R. Prins
7. X-ray Spectroscopy – B. Bertin
8. Introduction to X-ray Spectroscopy – R. Jenkins
9. Practical X-ray Spectroscopy – David E. Newbury
10. Photoelectron Spectroscopy – D. Briggs, J.T. Grant

**M. Sc. Forensic Science Semester - III**  
**DSC: MFS3T03E: Physical Evidence - I**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02**

**30 Lectures/Semester**

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**Course Objectives**

1. To provide theoretical and practical understanding of physical trace evidence such as fibres, paints, soil, and glass in forensic investigations.
2. To impart knowledge of collection, preservation, examination methods, and interpretation of such evidence with reference to case studies.

**Course Outcomes**

1. Students will gain knowledge about different types, properties, and forensic importance of fibres, paints, soils, and glass.
3. They will learn standard operating procedures for the collection, preservation, and laboratory examination of trace evidence.
4. They will acquire skills in physical, microscopic, and instrumental methods of analysis used in forensic science.
5. Students will develop competency in interpreting evidential value and linking trace evidence to criminal cases through case studies.
6. They will understand the significance of geo-forensics and material evidence in modern forensic investigations.

**Unit I:**

**Fibres:** Types of fibres, Classification and properties of fibres, Physical and Instrumental analysis of fibres, Collection of fibre evidence, Interpretation of fibre evidence, Case studies.

**Unit II:**

**Paints:** Types of paint and their composition, physical examination of paint, instrumental analysis of pigment, interpretation of paint evidence, Standard Operating Procedures for examination, Case Studies.

**Unit III:**

**Soil:** Formation and types of soil, composition and colour of soil, particle size distribution, Instrumental analysis of soil, Interpretation of soil evidence, Standard Operating Procedures for examination, Geo-forensics as an important tool in Forensic Investigations, Case Studies.

**Unit IV:**

**Glass:** Types of glass and their composition, Types of glass fractures, Forensic examination of glass fractures, Physical and Microscopic examination of glass evidence, Standard Operating Procedures for examination, Case Studies.

**Suggested Readings**

1. Forensic Science – Richard Saferstein
2. Forensic Science: An Introduction to Scientific and Investigative Techniques – Stuart H. James, Jon J. Nordby
3. Criminalistics: An Introduction to Forensic Science – Richard Saferstein
4. Introduction to Forensic Sciences – William G. Eckert
5. Forensic Science in Criminal Investigation and Trials – B.R. Sharma
6. Principles and Practice of Criminalistics: The Profession of Forensic Science – Keith Inman, Norah Rudin
7. Forensic Examination of Fibres – J. Robertson, M. Grieve
8. Forensic Examination of Glass and Paint: Analysis and Interpretation – Brian Caddy
9. Soil Analysis in Forensic Taphonomy – M. Tibbett, D.O. Carter
10. Advances in Forensic Human Identification – Xanthe Mallett, Teri Blythe, Rachel Berry

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T04E: Ballistics - I

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives

1. To teach the fundamentals of internal and external ballistics, trace-mark examination, and gunshot residue (GSR) analysis with emphasis on physical principles and measurement techniques.
2. To develop practical skills for collection, laboratory examination, interpretation and reporting of firearm-related evidence in forensic investigations.

#### Course Outcomes

1. Students will be able to explain the physics of propellant ignition, internal and external ballistic behaviour, recoil and factors that affect projectile trajectories.
2. They will demonstrate competence in methods used to measure chamber pressure, recoil, projectile velocity and to model trajectory including effects of air resistance and Coriolis forces.
3. Students will be able to collect, preserve and examine firearms evidence and fired ammunition, recognise class and individual characteristics, and apply microscopy and comparison techniques for identification.
4. They will understand the chemistry and detection methods for gunshot residue, and be able to apply visual, chemical and instrumental (SEM-EDX, AAS, XRF, NAA) approaches and relevant SOPs to evaluate GSR evidence.
5. They will be prepared to choose appropriate X-ray/SEM/microscopy methods, document findings, and communicate forensic conclusions clearly for investigative and legal contexts.

#### Unit I:

**Internal Ballistics:** Ignition and burning of propellants, degressive and progressive powders, rate of burning of propellants, factors affecting internal ballistics of projectiles, recoil, Measurement of recoil, Vibration and jump, Barrel Fouling, Chamber pressure and methods to measure chamber pressure.

#### Unit II:

**External Ballistics:** Equations of motion of projectiles, Vacuum trajectory, Effect of air resistance on trajectory, projectile velocity determination, gyroscopic stability, shape of projectile and ballistic coefficient of projectile and their effect on trajectory of projectile, Influence of Earth, wind direction, Escape Velocity and angle of fire on trajectory of projectile, Bullet drop, Ricochet.

#### Unit III:

**Trace Marks:** Location of marks and injuries due to firearm and ammunition on the victim and the culprit, Marks on firearm and fired ammunition, Collection of firearm, fired cartridges, fired bullets, clothes. Class and Individual characteristics of firearms and ammunition, Identification basis of firearm on examination of marks of firing pin, breech face, chamber, extractor, ejector, bullet, pellets. Methods to obtain Test Bullets, Use of Stereo-microscopy, Comparison Microscopy, Scanning Electron Microscopy, Striagraphy, Casting, Macro-photography, Periphery Camera, Comparison Camera to examine fired ammunition

## **Unit IV:**

**Gun Shot Residues:** Detectable components of Black Powder and Smokeless Powder Residues, Methods to detect GSR on the site of occurrence, Collection methods – Dry Methods, Wet Methods, Collection of Organic Residues, Evaluation Methods – Visual, Infrared Photography, Soft X-rays radiography, Chemical Methods viz. Dermal Nitrate Test, Walker's Test, Harrison and Gilroy's Test, Price's Spot Test, Griess Test, Elemental Analysis Methods – Neutron Activation Analysis, Flameless Atomic Absorption Spectrometry, Scanning Electron Microscopy, X-ray fluorescence.

## **Suggested Readings**

1. Handbook of Firearms and Ballistics: Examining and Interpreting Forensic Evidence, Brian J. Heard
2. Ballistics: Theory and Design of Guns and Ammunition, Donald E. Carlucci, Sidney S. Jacobson
3. Firearm and Toolmark Examination and Identification (Advanced Forensic Science Series), Max M. Houck (editor)
4. Firearms, the Law, and Forensic Ballistics, Tom Warlow
5. Applied Ballistics for Long Range Shooting, Bryan Litz
6. Modern Exterior Ballistics: The Launch and Flight Dynamics of Symmetric Projectiles, R. McCoy
7. Chemical Analysis of Firearms, Ammunition, and Gunshot Residue, James Smyth Wallace
8. Forensic Ballistics (regional/academic texts), Karan Sharma
9. Forensic Science: An Introduction to Scientific and Investigative Techniques, Stuart H. James, Jon J. Nordby
10. Principles and Practice of Criminalistics: The Profession of Forensic Science, Keith Inman, Norah Rudin

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3P01E: Practical - I**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 04**

**120 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Students will be able to operate spectroscopic instruments and record spectra of unknown samples.
2. They will acquire the ability to analyse and interpret spectra and diffraction photographs for material identification.
3. Learners will develop expertise in collection, examination, and comparison of forensic trace evidence (paint, glass, soil, fibres).
4. They will understand and apply methods for firearm and ammunition analysis including bullet, cartridge, and case comparison.
5. Students will gain practical skills for documentation, evaluation, and presentation of forensic laboratory findings.

**List of Practicals (Minimum of 12 have to be completed)**

1. To Record/Analyse the UV-visible Spectrum of a Sample
2. To Record/Analyse the Fluorescence Spectrum of a Sample
3. To Record/Analyse the IR Spectrum of a Sample
4. To Record/Analyse the Raman Spectrum of a Sample
5. To Record/Analyse X-ray Diffraction Photograph
6. To Record/Analyse Powder Photograph by Debye Scherrer Method
7. To Record/Analyse Laue Photograph
8. To Record/Analyse X-ray Fluorescence Spectrum
9. Examination and Analysis of Paint Chips Collected from Hit and Run Cases
10. Examination and Analysis of Glass Pieces Collected from Hit and Run Cases
11. Determination of Refractive Index of Glass Fragments
12. Examination of Soil Samples (Chemical and Microscopic)
13. To Determine Density and Density Gradient of Soil
14. To Determine Particle Size of Evidence
15. Examination of Fibre Samples
16. To Study Characteristics of Firearms
17. Examination and Comparison of Fired Bullets
18. Examination and Comparison of Fired Cartridges/Cases

**Suggested Readings**

1. Principles of Instrumental Analysis – Skoog, Holler, Crouch
2. Elements of X-ray Diffraction – B.D. Cullity, S.R. Stock
3. Forensic Examination of Glass and Paint: Analysis and Interpretation – Brian Caddy
4. Forensic Examination of Fibres – J. Robertson, M. Grieve
5. Handbook of Firearms and Ballistics – Brian J. Heard

## M. Sc. Forensic Science Semester - III

### DSE: MFS3T05E: Electronics

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives

1. To introduce the fundamental principles of semiconductor devices, amplifiers, oscillators, and digital electronics.
2. To develop the ability to analyze, design, and apply basic electronic circuits for real-world applications.

#### Course Outcomes

1. Students will understand the working principles, characteristics, and applications of semiconductor devices such as diodes, transistors, FETs, MOSFETs, and SCRs.
2. They will be able to analyze and design circuits involving operational amplifiers, photo-sensitive devices, and regulated power supplies.
3. Students will learn the theory and practical implementation of oscillators, waveform generators, and multivibrator circuits.
4. They will gain knowledge of logic gates, combinational circuits, flip-flops, counters, shift registers, and memory elements in digital electronics.
5. Learners will develop circuit analysis and problem-solving skills applicable to instrumentation, communication, and control systems.

#### Unit I:

**Basic Electronics:** Semiconductors – Intrinsic and Extrinsic, Principle, Characteristics and Applications of PN Junction, Bipolar Junction Transistor, Field Effect Transistor, MOSFET, Unijunction Transistor, Silicon Controlled Rectifier.

#### Unit II:

**Electronic Devices:** Integrated Circuits, Principle, Characteristics and Applications of Operational Amplifier, Photo Diode, Light Emitting Diode, Liquid Crystal Display, Photo Transistor, Zener Regulated Power Supply, Transistor amplifiers.

#### Unit III:

**Oscillators:** Barkhausen criterion for oscillations, phase shift oscillator, Wein-bridge oscillator, LC tunable oscillators – Hartley, Colpitts, comparators, square wave and triangular wave generators, multi-vibrators – astable, monostable, Bistable.

#### Unit IV:

**Digital Electronics:** Logic gates, Types of logic gates, Use of Transistors to construct logic gates, NAND and NOR gates as universal building blocks, Combinational circuits – Ex-OR gate, Half and Full Adder, flip-flops, counters, shift registers, memories.

#### Suggested Readings

1. Integrated Electronics – Jacob Millman, Christos Halkias
2. Electronic Devices and Circuit Theory – Robert L. Boylestad, Louis Nashelsky
3. Microelectronic Circuits – Adel S. Sedra, Kenneth C. Smith
4. Principles of Electronics – V.K. Mehta, Rohit Mehta
5. Electronic Principles – Albert Malvino, David Bates
6. Modern Digital Electronics – R.P. Jain
7. Operational Amplifiers and Linear Integrated Circuits – Ramakant A. Gayakwad
8. Digital Design – M. Morris Mano
9. Basic Electronics: Devices, Circuits and IT Fundamentals – Debashis De
10. Fundamentals of Digital Circuits – A. Anand Kumar

**M. Sc. Forensic Science Semester - I**

**DSE: MFS3P02E: Practical - II**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02**

**60 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Students will be able to analyze the characteristics of diodes, transistors, FETs, SCRs, LEDs, and photo diodes.
2. They will gain practical knowledge of biasing, rectification, regulation, and amplification in electronic circuits.
3. Students will understand the applications of operational amplifiers, oscillators, and multivibrators.
4. They will acquire the ability to design and implement logic gates, combinational logic, and flip-flops for digital electronics applications.

**List of Practicals (Minimum of 8 have to be completed)**

1. Study of PN Junction Diode
2. Study of Biasing of Transistors
3. Study of Rectifiers
4. Study of Field Effect Transistors
5. Study of Characteristics and Applications of Silicon Controlled Rectifier
6. Design of Regulated Power Supply
7. Study of LED Characteristics
8. Study of Characteristics of Photo Diode
9. Study of Transistor Amplifiers
10. Study of Operational Amplifier Applications
11. Study of Oscillators
12. Study of Multivibrators
13. Study of Logic Gates
14. Study of Combinational Logic Circuits
15. Study of Flip-Flops

**Suggested Readings**

1. Integrated Electronics – Jacob Millman, Christos Halkias
2. Electronic Devices and Circuit Theory – Robert L. Boylestad, Louis Nashelsky
3. Microelectronic Circuits – Adel S. Sedra, Kenneth C. Smith
4. Operational Amplifiers and Linear Integrated Circuits – Ramakant A. Gayakwad
5. Modern Digital Electronics – R.P. Jain

## M. Sc. Forensic Science Semester - III

### DSC: MFS3T06: Special Law - I

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02

30 Lectures/Semester

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#### Course Objectives

1. This course is designed to provide in-depth knowledge of special criminal laws related to forensic science in India.
2. It aims at equipping students of forensic science with knowledge of legal procedure prescribed under different special criminal laws.

#### Course Outcomes

1. Learn special legislations related to Forensic Chemistry and toxicology in India.
2. Learn special legislations related to Environmental and Wildlife Forensics in India.
3. Understand the necessity of special criminal legislation for forensic science students.

#### Unit I- Drug Legislation of India

The Narcotic Drugs and Psychotropic Substances Act, 1985 (Object, Definitions, Authorities and officers, Prohibition control and regulation under Act, Offences and Penalties, Special Courts and its Procedure)

The Prevention of Illicit Trafficking in NDPS Act, 1988

#### Unit II- Food legislation of India

The Food Safety and Standards Act, 2006 (Preliminary, Food safety and Standard Authority of India, General principles of Food safety, General provisions as to articles of food, Analysis of Food, Enforcement provisions, Offences and Penalties)

#### Unit III- Environment protection under Indian law

Meaning and Definition of Environment, Environmental Pollution, Its kinds (Natural and Artificial – Air, Water, Noise, Soil), causes and effects of pollution.

Environment Protection under the Constitution of India

The Environmental Protection Act, 1986 (Definitions, Measures taken for protection and conservation of natural resources, Authorities, offences and penalties and important judicial decisions)

#### Unit IV- Wildlife protection under Indian law

The Wildlife Protection Act, 1972 (Important Definitions, Authorities under the Act, Wildlife Advisory Board, Hunting, Protection of Specified plants, Sanctuaries and National Parks, Central Zoo Authority and Recognition of Zoos, Trade or commerce in Wild Animals, animal articles and trophies, Forfeiture of Property Derived from Illegal Hunting and Trade, Offences and Penalties, important judicial decisions)

#### Suggested Readings

1. The Food Safety and Standards Act, 2006 (Bare Act) Professional Book Publishers, Delhi
2. Prevention of Illicit Trafficking in NDPS Act, 1988 (Bare Act) Professional Book Publishers, Delhi
3. Narcotic Drugs and Psychotropic Substances Act, 1985 (Bare Act) Professional Book Publishers, Delhi
4. Sarkar's Criminal Minor Acts by S.K. Sinha Ray, LexisNexis New Delhi
5. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, Oxford University Press, New Delhi
6. Environmental Law in India, P. Leelakrishnan, LexisNexis, New Delhi.
7. The Wildlife Protection Act 1972 (Bare Act)

**M. Sc. Forensic Science Semester - III**

**DSC: MFS3RP: Project**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 04**

**120 Lectures/Semester**

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The Research Project is a core practical component of the program, designed to train students in the essential processes of scientific inquiry and research methodology. The project aims to develop the learner's ability to identify a research problem, conduct a comprehensive literature review, formulate a research hypothesis, and design appropriate methodologies to test the hypothesis. Students are expected to collect, analyze, and interpret data using relevant tools and techniques to draw logical and evidence-based conclusions.

The project emphasizes the development of critical thinking, problem-solving, and academic writing skills. It also prepares students to effectively present their research findings through written reports, oral presentations, and, where applicable, research publications.

The course serves as a preparatory step for doctoral-level research and professional scientific contributions.

Evaluation will be based on the quality of the project report, a viva-voce presentation, and adherence to the assessment criteria outlined in the Evaluation Rubrics.

# **Semester – IV**

**Specialization – I**  
**Questioned Documents**  
**and Fingerprints**

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T01A: Questioned Document Analysis- II**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. Provide comprehensive knowledge of forensic examination techniques used in the analysis of questioned documents.
2. Develop an understanding of handwriting, imprint, and reprographic examinations, along with the practical challenges encountered during questioned document analysis.
3. Develop analytical and reporting skills required for forensic document examination through case studies and structured report writing.

**Course Outcomes:** By the end of this course the learners will be able to:

1. Demonstrate understanding of forensic examination techniques through case studies and practical application.
2. Apply standards and guidelines in questioned document examination to ensure reliability and admissibility of expert testimony in court proceedings, and effectively write comprehensive reports.
3. Analyze the characteristics of financial crimes considering various paper and non-paper assets involved in financial transactions, and tracing the paper liabilities trail for investigative purposes.
4. Apply problem-solving skills to address challenges encountered during the examination of questioned documents, financial crime investigations.

**Unit I: Forensic Examination**

Determination of sequence of intersecting strokes, examination of creases and folds, determination of sequence of writings over creases & folds. Factors and Characteristics of Detection, Reconstruction and examination of torn documents, Charred Documents: Stabilization and their examination, Case Studies, Handwriting examination, Imprint examination, Reprographic examination, Problems faced during examination of questioned document.

**Unit II: Standards and Guidelines in Questioned Document Examination**

Standards of Practice for the Examination of handwriting, Reliability of Interpretation, Daubert Standards- Court Acceptance of Expert Testimony, Frye Standard – Scientific Evidence and the Principle of General Acceptance, Scientific Validity of handwriting for Admissibility as evidence, ANSI/ASB Standards, SWGDOC Standards for Forensic Document Examiners, Report writing.

### **Unit III: Financial Crimes**

Characteristics of Financial Crimes, Spending, Saving, structure, Conspiracy, categories of theft, Burglary, Larceny, Robbery, Embezzlement, Swindle, Schemes, Paper Liabilities trail, check registers, stocks and Bonds, Real property, Vehicle, other assets, Jewelry, Furs and Clothing, Antiques, Philately, Numismatic, Artwork.

### **Unit IV: Examination of Other Documents**

Types and working of Photostat machine, fax machine, printers, scanners. Identification & linkage of Photocopies and photocopier, typewriter, fax machine, scanner, Desktop printing including image processing device, their role in counterfeit currency, travel documents and certificates, Forensic examination of e-documents including digital signatures, Case studies.

### **Suggested Readings:**

1. Forensic Handwriting Identification Fundamental concepts and Principles, Academic Press by Ron. Morris.
2. Suspect Documents, their Scientific Examinations, Nelson-Hall By W. Harrison
3. Scientific Examination of Questioned Documents, Second Edition, CRC Press, Taylor and Francis Group By Kelly, J.S. and Lindblom S.B.
4. Handwriting Identification: Facts and Fundamental, CRC Press, Boca Raton By Huber, R. A. and Headrick.
5. Scientific Examination of Questioned Documents, CRC Press By O.Hilton.
6. Law and Techniques relating to Identification of Handwriting, Disputed Documents, Fingerprints, Footprints. Revised by Atul Kumar Singla By B.L. Saxena
7. Treatise on handwriting forensics. Universal Law Publishing Co. New Delhi By B.R. Sharma
8. Scientific Examination of Documents: Methods and Techniques By D. Ellen
9. Encyclopedia of Forensic Sciences Edited By Jay A. Siegel & Pekka J. Sauko.

## M. Sc. Forensic Science Semester - IV

### DSC: MFS4T02A: Advanced Fingerprint Development Method- II

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02 30 Lectures/Semester

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#### Course Objectives:

1. Provide in-depth knowledge of advanced metal deposition methods and optical techniques used in the visualization and development of latent fingerprints.
2. Develop conceptual understanding of nanotechnology and nanoparticle chemistry, synthesis, properties, and stability, with specific application to fingerprint development and forensic investigations.
3. Provide knowledge to the students with future perspectives and research trends in fingerprint science, including nanotechnology-driven innovations and advanced imaging systems.

#### Course Outcomes: By the end of this course the learners will be able to:

1. Understand the principles and mechanisms of metal deposition methods.
2. Apply knowledge of nanoparticles in fingerprint development.
3. Analyze advanced fingerprint development methods, such as radioactive, biological, and chemical imaging techniques, for latent fingerprint development on challenging surfaces and substrates.
4. Evaluate enhancement techniques for fingerprints in blood, to enhance and maximize the number of fingerprints.
5. Develop comprehensive strategies for latent fingerprint detection and enhancement in forensic investigations.
6. Apply problem-solving skills to address challenges encountered in fingerprint development and enhancement, including selection of appropriate methods, sequencing of techniques, and optimization of results for effective forensic analysis and evidence processing.

#### Unit I: Metal Deposition Methods

Laser induced fluorescence, Infrared luminescence, Single Metal Deposition, Multi-metal deposition- I, II, III, IV, fluorescent and vacuum metal deposition-reaction mechanism, conventional gold zinc process, sequencing, Lipid Reagent: Sudan black, chemistry and mechanism of Oil red O, Nile red, European chelate.

#### Unit II: Nanoparticles in Fingerprint

Introduction, Structure and properties of nanoparticles, Synthesis of nanoparticles (AuNPs, AgNPs), Role of nanotechnology in Forensics, role of nanotechnology in fingerprint development, stability of nanoparticles in solution: Van der Waals interactions, electrostatic repulsion, Steric

Hindrance, Optical properties, Types of nanoparticles, Visualizing Fingermarks using nanoparticles, Future Perspectives.

### **Unit III: Advanced Methods**

Techniques of latent fingerprint development: Radioactive, Biological, reflected ultraviolet Imaging system, X-ray fluorescence, Chemical imaging. Development of Latent fingerprints on challenging surfaces. Deposition and development latent print on gloves, Adhesive tape-Tape separation method, processing the adhesive and non-adhesive side of tape. Skin- Iodine silver plate transfer, Electronography, Powder method, Iodine-Naphthoflavone, Direct lifting method.

### **Unit-IV: Enhancement Techniques for Blood-stained Fingerprints**

Introduction, Development of techniques for proof and enhancement of blood, Heme Techniques, Protein staining blood enhancement techniques, Powder suspension techniques, amino acid techniques, DCF-DA dye methods, Spectrophotometric and spectrofluorimetric methods, Application of enhancement techniques, Aging of bloodstains, Sequencing of techniques to maximize enhancement and number of fingerprints.

### **Suggested Readings:**

1. Advances in Fingerprint Technology By Lee and Gaensslen's
2. Fingerprint Development Techniques Theory & Application By Stephen M. Bleay, Ruth S.Croxton, Marcel De Puit
3. Fundamentals of Fingerprint Analysis By Hillary Moses Daluz.
4. Advanced Forensic Science Series Forensic Fingerprints Edited By Max M. Houck.
5. *Fingerprints and Other Ridge Skin Impressions* (2nd Ed.), CRC Press. By Champod, C., Lennard, C., Margot, P., &Stoilovic, M.
6. The Fingerprint Sourcebook, U.S. Department of Justice By Holder, E. H., Robinson, L. O., & Laub, J. H.

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T03A: Forgery and Its Forensic Detection**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. Provide comprehensive understanding of different types of forgeries and develop analytical skills for the scientific examination and interpretation of signatures and handwriting.
2. Enhance knowledge of security features and anti-counterfeiting measures in documents.
3. Strengthen practical competence and case interpretation skills through the study of real and simulated case studies.

**Course Outcomes:** By the end of this course the learners will be able to:

1. Understand the various types and attributes of forgery, as well as physical constraints and methods of detection and decipherment of alterations and erasures in documents.
2. Analyze signatures and handwriting characteristics to distinguish between genuine and forged signatures.
3. Apply techniques for the examination of security documents, and to analyze security features.
4. Evaluate the types and functions of document examination equipment, through examination and case studies.
5. Apply the principles and practices of graphology through case studies and trait analysis.
6. Synthesize knowledge of handwriting analysis, security document examination, and document examination equipment to develop comprehensive strategies for detecting and preventing document fraud, and differentiating between genuine and counterfeit documents.

**Unit I: Forgery**

Types of forgery, attributes of assisted hand signatures, disguise, discriminators of device, flag of forgery and characters of genuineness, indicators of illiteracy, sign of senility, symbol of sinistrality, gender discrimination. Physical constraints, detection and decipherment of alterations and erasures including additions, over writings, obliterations, Numismatic forgery- Introduction, tool, equipment, method of forgery- alteration, tooling, embossing, application and plating, Casting: Rubber mold model, wax model from mold, burn out wax, treatment of casting, creating dye-cutting by hand, plating, casting and hubbing.

**Unit II: Signatures and Handwriting**

Examination of signatures – characteristics of genuine & forged signatures, identification of writer of forged writings/signatures, Importance of tremor in identification of writings and signatures,

difference between tremors of fraud and genuine tremors in writings and signatures, hesitations, factors responsible for variations (under threat, while travelling, illness, old age, mental state).

### **Unit III: Security Documents**

Examination of security documents by VSC including currency notes, Revenue stamps, travel documents - passports, visas, air - tickets, identity cards, lottery tickets, driving license, Bills, educational and financial documents, etc. different types of security features and their examination including watermarks, wire marks, security fiber/threads, Ghost/imitated marks/ security printing, optical variable inks, holograms and other security features, Examination of credit, debit and other plastic cards.

### **Unit IV: Graphology**

Definition, History of Graphology, Characteristics of handwriting, Graphology and Identification of Handwriting, Emotions and feeling, loops, Envelopes, Graphomania, Signature, Position on the page, doodles, numbers. Applications of Graphology, Ethical Considerations, Assessment and Evaluation, Trait analysis: Identifying personality traits through handwriting, Emotional analysis: Interpreting emotions and mood from handwriting, Case Studies.

### **Suggested Readings:**

1. Forensic Handwriting Identification Fundamental concepts and Principles, Academic Press by Ron. Morris.
2. Suspect Documents, their Scientific Examinations, Nelson-Hall By W. Harrison
3. Scientific Examination of Questioned Documents, Second Edition, CRC Press, Taylor and Francis Group By Kelly, J.S. and Lindblom S.B.
4. Handwriting Identification: Facts and Fundamental, CRC Press, Boca Raton By Huber, R. A. and Headrick.
5. Scientific Examination of Questioned Documents, CRC Press By O.Hilton.
6. Law and Techniques relating to Identification of Handwriting, Disputed Documents, Fingerprints, Footprints. Revised by Atul Kumar Singla By B.L. Saxena
7. Treatise on handwriting forensics. Universal Law Publishing Co. New Delhi By B.R. Sharma
8. Scientific Examination of Documents: Methods and Techniques By D. Ellen
9. Encyclopedia of Forensic Sciences Edited By Jay A. Siegel & Pekka J. Sauko.
10. Handwriting Analysis: The Science of Determining Personality By Bunker, J. A.

## M. Sc. Forensic Science Semester - IV

### DSC: MFS4T04A: Automated Fingerprint Identification System

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02 30 Lectures/Semester

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#### Course Objectives:

1. Provide comprehensive understanding of the historical development, structure, standards, and functioning of Automated Fingerprint Identification Systems.
2. Train the students in scientific methods of latent fingerprint recognition, examination, identification, and individualization.
3. Familiarize students with emerging technologies in fingerprint sensing and biometric identification

**Course Outcomes:** By the end of this course the learners will be able to:

1. Understand the history, development, and functioning of automated fingerprint identification systems (AFIS), including different classification systems.
2. Explain the processes involved in forensic fingerprint identification, fingerprint verification systems, and fingerprint matching.
3. Demonstrate expertise in recognizing, examining, and identifying latent prints using various methods
4. Understand the protocols and techniques for enhancing and assessing fingerprint quality.
5. Understand the factors affecting the reliability of fingerprint evidence, and the procedures for collecting, preserving, and presenting fingerprint evidence.
6. Apply advanced methods for fingerprint quality assessment and enhancement.
7. Prepare and present forensic fingerprint evidence effectively, demonstrating techniques for effective testimony and cross-examination as an expert witness, while addressing common misconceptions and ensuring the reliability of fingerprint evidence.

**Unit I: Fingerprints and AFIS:** History of automated identification system: Early print, single database, growth, and development of AFIS system, Transmission standard, ANSI standard, compression standard. NCIC classification system, Henry and American classification system, working of AFIS- Database, processing ten print, latent print processing, latent search. Types of AFIS searches: Ten print to Ten print search, Latent to ten prints searches, Latent to latent search. AFIS report: Ten print report and latent print report. Fingerprint Databases.

**Unit II: Automated Fingerprint classification systems:** History of pattern recognition development of fingerprint classification system, forensic fingerprint classification system, Forensic Fingerprint Identification, Diffusion of Fingerprint system, Automation fingerprint system.

Mathematical model of fingerprint topology, Fingerprint verification system, Fingerprint representation, Fingerprint matching, Transition of configuration.

**Unit III: Identification of Latent Print:** Introduction, recognition and examination, Identification and Individualization by Osborn grid method, Seymour method, Photographic strip method, Polygon method, Overlay method, Osterberg method, microscopic triangulation method, conventional method, Identification protocol and reconstruction of latent print. Fingerprint quality assessment: Introduction, assessing fingerprint quality, non-uniform contact, Inconsistent contact, enhancing Fingerprint image by Directional Fourier filtering, Advances in Fingerprint sensor using RF Imaging Technique- Introduction, taxonomy of Fingerprint sensing method.

**Unit-IV: The Expert Fingerprint Witness:** Definition of expert, Qualification, Knowledge- History and classification of fingerprint, latent print procedure. Factors affecting the reliability of fingerprint evidence. Misconceptions and myths about fingerprint identification. Collection and preservation of fingerprint evidence, Preparation of reports and documentation for court, Role of the expert witness in the courtroom, Techniques for effective testimony and cross-examination.

**Suggested Readings:**

1. Fingerprints and Other Ridge Skin Impressions (2nd Ed.), CRC Press ByLennard, C., Margot, P., & Stoilovic, M.
2. Advances in Fingerprint Technology (2nd / 3rd Ed.), CRC Press by Lee, H. C. & Gaensslen, R. E.
3. Handbook of Biometrics, Springer By Jain, A. K., Flynn, P., & Ross, A. A.
4. Biometrics: Personal Identification in Networked Society, Springer by Jain, A. K., Bolle, R., & Pankanti, S.

## M. Sc. Forensic Science Semester - IV

### DSC: MFS4P01A: Practical - I

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 02 60 Lectures/Semester

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Examine and authenticate security and questioned documents (currency, travel documents, plastic cards, printed, scanned, and electronic documents) using appropriate forensic and instrumental techniques.
2. Analyze handwriting, signatures, and writing characteristics to determine sequence of strokes, detect alterations, identify tremors, and examine writing on unusual surfaces.
3. Detect and interpret various types of forgeries and manipulations, including copy-move forgery, transplantation, obliterations, and security document fraud using optical and digital tools such as VSC.
4. Apply scientific and analytical methods, including graphological assessment and basic statistical analysis, to support forensic examination and interpretation of evidence.

#### **Practical: (Minimum of 08 has to be completed)**

1. Forensic examination of security features of Currency / Bank Notes.
2. Forensic examination of security features of travel documents.
3. Forensic examination of security features of Credit / Debit Card
4. Determination of sequence of strokes.
5. Forensic examination of creases and folds.
6. Forensic examination of copy-move/ transplantation forgery.
7. Forensic examination of forgeries in security documents.
8. Forensic examination of alterations and obliterations by VSC.
9. Graphological Analysis of handwriting.
10. Preparation of Excel sheet for data entry and use of various statistical and graph functions.
11. Forensic examination of type scripts/printed matter/Scanned documents/fax.
12. Forensic examination of hand writing on unusual surfaces.
13. Identification of genuine and fraud tremors in handwriting.
14. Forensic examination of e-documents.
15. Synthesis of nanoparticles.
16. Scientific Report Writing

## M. Sc. Forensic Science Semester - IV

### DSE: MFS4T05A1: Insurance Fraud Investigation

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02 30 Lectures/Semester

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#### Course Objectives:

1. Provide fundamental understanding of insurance concepts and principles and familiarize students with various types of insurance and their regulatory frameworks.
2. Introduce the forensic dimensions of insurance fraud and develop analytical skills for insurance claim investigation.
3. Enhance understanding of the role of forensic experts in insurance-related litigation and build competence in documentation and reporting

#### Course Outcomes: By the end of this course, the learners will be able to

1. Define and explain basic insurance concepts, principles, risk and uncertainty, and insurance as a risk transfer mechanism.
2. Identify and differentiate between various types of insurance such as health, life, property, motor vehicle, and other insurance products available in India.
3. Analyze real-life insurance fraud cases to apply forensic principles effectively.
4. Identify red flags and suspicious patterns in insurance claims, focusing on key areas for fraud detection.
5. Explain methods for collecting information, including document analysis, site visits, and expert consultations.
6. Identify sources of information such as public records, financial documents, and forensic reports. Explain the importance of evidence storage and the structure and format of forensic investigation reports.

#### Unit 1: Fundamental of Insurance

Basics of Insurance Concepts, Principles, Risk and uncertainty, Insurance as a risk transfer mechanism. History Insurance terminologies, Insurance business and its market, The insurance contract and policy, Insurance products. Components of an insurance policy: declarations, insuring agreement, exclusions, conditions, endorsements. Steps involved in filing and processing an insurance claim.

## **Unit 2: Insurance Types**

Introduction to types of Insurance; Health Insurance, Life Insurance, Property Insurance, Motor Vehicle Insurance, and other Insurance Products in India, Underwriting Principles, Policy Forms and Clauses, Regulatory and Legal Aspects, High-risk profiles, Support of forensic experts in insurance-related litigation, including expert witness testimony and evidence presentation.

## **Unit 3: Forensic Aspects of Insurance Frauds**

Introduction to Insurance Frauds, Health Insurance Frauds, Life Insurance Frauds, Principle ethics for Insurance, Investigator, Definition and principles of subrogation in insurance, Forensic aspects of subrogation investigations, Ethical issues faced by forensic professionals in insurance investigations, Analysis of real-life insurance fraud cases.

## **Unit 4: Insurance Claim Investigation**

Claims process and its challenges, Identifying red flags and suspicious patterns in insurance claims, Key areas to focus for detection of Fraud, Methods for collecting information, including document analysis, site visits, and expert consultations, Sources of information, such as public records, financial documents, and forensic reports, Evidence storage, Structure and format of forensic investigation reports.

### **Suggested Readings:**

1. Fraud Typologies and Investigation By Button, M., Lewis, C., & Tapley, J.
2. Manuals on Economic Offences and Financial Fraud Investigation, BPR& D (India).
3. IRDAI Publications & Case Compendiums.
4. Fraud and Insurance: A Crime and Economic Analysis by Derrig, R. A. & Weisberg, H. I. (Editors).
5. *Principles of Fraud Examination* – Wiley By Wells, J. T.
6. Principles of Risk Management and Insurance by Rejda, G. E. & McNamara, M. J.
7. Fraud Auditing and Forensic Accounting: New Tools and Techniques by Bologna, G. J. & Lindquist, R. J.

## M. Sc. Forensic Science Semester - IV

### DSE: MFS4P02A1: Practical - II

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 02    60 Lectures/Semester

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Explain and apply fundamental insurance concepts and policy structures, including risk, uncertainty, policy components, types of insurance.
2. Analyze insurance policies and claims critically to identify key clauses, similarities and differences among policy forms, suspicious patterns, and red flags indicative of potential insurance fraud.
3. Conduct basic forensic investigations of insurance fraud cases, including document examination, analysis of real and simulated cases, ethical decision-making, evidence collection, and preparation of investigative reports.
4. Integrate theoretical knowledge with professional practice through mock investigations, expert consultations, and educational visits to insurance and financial institutions.

#### **Practical: (Minimum of 08 has to be completed)**

1. Create a presentation explaining the basic concepts and principles of insurance, including risk and uncertainty.
2. Analyze a sample insurance policy to identify and explain its components: declarations, insuring agreement, exclusions, conditions, and endorsements.
3. Simulate the steps involved in filing and processing an insurance claim through a role-playing exercise, including the completion of claim forms and understanding the claims process.
4. Research and prepare a report on different types of insurance available in India (Health, Life, Property, Motor Vehicle, etc.) and their key features.
5. Review and compare different policy forms and clauses for various types of insurance, identifying key similarities and differences.
6. Forensic examination of keys
7. Analyze and discuss real-life insurance fraud cases, identifying the types of fraud and the methods used to detect them.
8. Investigate a simulated case of health insurance fraud, documenting the fraudulent activities and suggesting preventive measures.
9. Conduct an investigation for a mock insurance claim, outlining the steps taken and the ethical considerations involved.
10. Review and analyze sample insurance claims to identify suspicious patterns and potential red flags indicating fraud.

11. Conduct a mock investigation of an insurance claim, using document analysis, site visits, and expert consultations to gather evidence.
12. Compile and evaluate information from various sources (public records, financial documents, forensic reports) for a simulated insurance claim investigation.
13. Educational Visit to Financial Institutions/Insurance Agencies.
14. Educational Visit to Corporate Office/Institutions/Organization/Companies.

## M. Sc. Forensic Science Semester - IV

### DSE: MFS4T05A2: Corporate Forensic Investigation

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02 30 Lectures/Semester

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#### Course Objectives:

1. To introduce the concepts, scope, and significance of corporate investigations, including financial, employee misconduct, due-diligence, insurance, and whistleblower investigations in organizational settings.
2. To develop foundational understanding of insurance systems and products.
3. To build analytical competence in detecting and investigating financial and corporate frauds,
4. To equip students with practical investigative skills, including interviewing, evidence collection and preservation, report writing, case analysis, ethical decision-making.

#### Courses Outcomes: By the end of this course the learners will be able to

1. Describe the definition, purpose, and importance of corporate investigations, and identify the key skills and competencies required for effective corporate investigators.
2. Explain the fundamental concepts, principles of insurance, policy types, forms, and clauses associated with these types of insurance.
3. Analyze financial statements to detect financial fraud and embezzlement, trace illicit funds, and identify money laundering schemes.
4. Perform comprehensive background checks on potential business partners, vendors, or clients, identifying potential risks, and formulating mitigating strategies.
5. Apply key techniques for detecting and investigating fraud, including conducting interviews, collecting and storing evidence, and writing detailed reports.
6. Apply internal controls and audits, understand and implement whistleblower programs, adapt to new technologies and methodologies in corporate investigations, anticipate future trends.

#### Unit I: Corporate Investigations

Definition and purpose of corporate investigations, Importance of corporate investigations in business, Overview of key skills and competencies required for corporate investigators, Financial investigations, Employee misconduct investigations, Due-diligence investigations, Corporate espionage investigations, Asset tracing investigation, Litigation support investigations, insurance investigations and Whistleblower investigations.

## **Unit II: Basics of Insurance**

Basics of Insurance-Concepts, Principles & History, Insurance products, Introduction to Motor Insurance, New trends in Motor Insurance, Applicability of insurance principles, Legal aspects of motor insurance, Underwriting in Motor Insurance, Policy Types, Forms and Clauses of Motor Insurance, Introduction to health insurance, Applicability of insurance principles, Legal aspects of motor insurance, Underwriting in health Insurance, Policy Types, Forms and Clauses of health Insurance, Property Insurance, Pre-nuptial contract.

## **Unit III: Financial Frauds**

Financial Investigations- Understanding financial statements, detecting financial fraud and embezzlement, tracing illicit funds, Identifying money laundering schemes, Anti-Money Laundering (AML), Employee Misconduct Investigations, Handling complaints and allegations, investigating harassment and discrimination claims, Addressing violations of company policies, KYC, CKYC & eKYC, Conducting background verification on potential business partners, vendors, or clients, Evaluating financial stability and reputation, Identifying potential risks and mitigating strategies.

## **Unit IV: Investigating Frauds**

Key areas to focus for detection of fraud, Conducting investigations & interviews, Collecting information-methods, sources, evidence storage, Report writing, Case Study- Analyzing real-life case studies of corporate investigation, Internal controls and audits, Whistleblower programs, Adapting to new technologies and methodologies, Anticipating future trends in corporate investigations, Balancing investigative tactics with employee rights and privacy concerns.

### **Suggested Book Readings:**

1. Fraud Typologies and Investigation By Button, M., Lewis, C., & Tapley, J.
2. Manuals on Economic Offences and Financial Fraud Investigation, BPR& D (India).
3. IRDAI Publications & Case Compendiums.
4. Fraud and Insurance: A Crime and Economic Analysis By Derrig, R. A. & Weisberg, H. I. (Editors).
5. Principles of Fraud Examination Wiley By Wells, J. T.
6. Principles of Risk Management and Insurance by Rejda, G. E. & McNamara, M. J.
7. Fraud Auditing and Forensic Accounting: New Tools and Techniques by Bologna, G. J. & Lindquist, R. J.
8. Forensic and Investigative Accounting – CCH By Crumbley, D. L., Heitger, L. E., & Smith, G. S
9. Market Abuse and Financial Crime by Rider, B., Alexander, K., & Linklater, S.

## M. Sc. Forensic Science Semester - IV

### DSE: MFS4P02A2: Practical - II

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 02 60 Lectures/Semester

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to-

1. Explain and demonstrate the role of corporate investigations in business, including financial investigations, due-diligence, corporate espionage, and insurance-related inquiries.
2. Analyze financial and insurance records critically to detect fraud, embezzlement, money laundering patterns, and policy-related irregularities using simulated datasets and case scenarios.
3. Conduct structured investigative procedures, including due-diligence, background verification (KYC/CKYC/eKYC), tracing illicit funds, whistleblower assessment, and application of ethical and legal principles.
4. Prepare professional investigation reports and recommendations, integrating findings from document analysis and simulated investigations.

#### **Practical: (Minimum of 08 has to be completed)**

1. Create a presentation explaining the definition, purpose, and importance of corporate investigations in business.
2. Analyze a mock financial statement to detect potential fraud or embezzlement activities.
3. Conduct a simulated due-diligence investigation on a potential business partner, evaluating financial stability and reputation.
4. Investigate a hypothetical case of corporate espionage, focusing on identifying sources and methods of data breaches.
5. Review and compare different types of motor insurance policies, identifying key forms and clauses.
6. Analyze different health insurance policies, focusing on applicability of insurance principles and legal aspects.
7. Create a case study on property insurance, including the process of filing a claim and understanding policy coverage.
8. Simulate tracing illicit funds and identifying money laundering schemes using sample financial data.
9. Conduct a background verification exercise using KYC, CKYC, and eKYC processes on a mock potential business partner.
10. Write a detailed investigation report based on a simulated fraud case, including findings and recommendations.
11. Design a whistleblower program for a fictional company, ensuring it aligns with best practices and legal requirements.
12. Explore and present new technologies and methodologies in corporate investigations, such as digital forensics and data analytics.
13. Educational Visit to Financial Institutions/Insurance Agencies.
14. Educational Visit to Corporate Office/Institutions/Organization/Companies.

# **Specialization – II**

## **Forensic Chemistry and Toxicology**

## M. Sc. Forensic Science Semester - IV

### DSC: MFS4T01B: Advanced Instrumentation – II

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02 30 Lectures/Semester

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#### Course Objectives:

1. To impart fundamental and advanced knowledge of the principles, instrumentation, and working mechanisms of modern analytical techniques such as XRD, XRF, Mass Spectrometry, SEM, TEM, TGA, and Electrophoresis.
2. To develop an understanding of sample preparation, operational parameters, and data interpretation involved in advanced instrumental methods used in chemical and forensic analysis.
3. To familiarize students with qualitative and quantitative analytical applications of instrumental techniques for material characterization and forensic investigations.
4. To enhance problem-solving skills by applying diffraction, spectrometric, microscopic, and thermal techniques to real-world analytical and forensic problems.
5. To enable critical evaluation of analytical techniques with respect to their accuracy, reliability, advantages, and limitations in scientific and forensic contexts.

#### Course Outcomes:

1. Identify the principles, components, and functions of XRD, XRF, MS, SEM, TEM, TGA, and Electrophoresis.
2. Describe the processes involved in sample preparation and analysis for each technique and discuss the forensic significance of these methods.
3. Apply these techniques to solve problems, such as determining the composition of a sample, analyzing surface details, and detecting and quantifying various substances.
4. Assess the strengths and limitations of XRD, XRF, MS, SEM, TEM, TGA, and electrophoresis in forensic science.
5. Critically assess the reliability and accuracy of these analytical techniques

#### Unit I: X-Ray diffraction (XRD) and X-Ray Fluorescence (XRF)

Diffraction, Working of XRD, Bragg's Law of Diffraction, Geometry of Diffractometer, Components of X-ray Diffractometer, Detector application of Powder XRD, Thin film XRD analysis, Single crystal XRD analysis, Determination of an Unknown sample, Strengths and Limitations of X-ray Powder Diffraction, X-ray Fluorescence (XRF), Energy Dispersive-XRF, Wavelength Dispersive-XRF, and Applications of Fluorescence methods, Forensic Significance, Advantages and limitations of XRD and XRF methods.

## **Unit II: Mass Spectrometry**

Introduction, Instrumentation of Mass Spectrometer (MS), (Ion source, Mass analyser, Ion detector) Fragmentation in pentane, Types of Mass Spectrometer, Ionization Methods in Organic Mass Spectrometry, Analysis and Separation of Sample Ions, Detection and recording of sample ions, The Nitrogen Rule, The Rule of Thirteen, Isotopes in Mass Spectrometry, Types of fragmentation, Fragmentation of various classes of organic molecules, Problems based on MS. Forensic applications, Advantages and Limitations.

## **Unit III: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and Thermal analysis techniques**

**SEM and TEM:** Introduction of SEM and TEM, working principle of SEM and TEM, SEM Components, Electron Source, Lenses, Scanning Coil, instrumentation and specimen preparation for transmission electron microscopy, application of SEM and TEM in surface details of microorganisms, cells and tissues, Forensic Applications, Advantages and limitations of SEM and TEM.

**Thermal Analysis:** Introduction, theory, instrumentation and Example of TGA curve, Information from TGA curve, factors affecting the TGA curve, Forensic applications of Differential Scanning Calorimetry, Thermo-Gravimetric Analysis and Differential Thermal Analysis

## **Unit IV: Electro analytical techniques and Electrophoresis**

**Polarography, Amperometry, voltammetry, electrogravimetry and cyclic voltammetry and stripping voltammetry:** Principle, theory, instrumentation and applications, Forensic applications, advantages and limitations.

**Electrophoresis:** Principle, theory, instrumentation and applications, Ion-exchange and Size Exclusion (Gel Permeation) Chromatography, Forensic applications, advantages and limitations.

### **Suggested Readings:**

1. Skoog, D. A., Holler, F. J., and Crouch, S. R., Principles of Instrumental Analysis, Cengage Learning.
2. Cullity, B. D. and Stock, S. R., Elements of X-Ray Diffraction, 3rd Ed., Pearson Education.
3. Jenkins, R. and Snyder, R. L., Introduction to X-Ray Powder Diffractometry, Wiley-Interscience.
4. Van Grieken, R. and Markowicz, A., Handbook of X-Ray Spectrometry, CRC Press.
5. Gross, J. H., Mass Spectrometry – A Textbook, 2nd Ed., Springer.
6. McLafferty, F. W. and Tureček, F., Interpretation of Mass Spectra, University Science Books.
7. Silverstein, R. M., Webster, F. X., and Kiemle, D., Spectrometric Identification of Organic Compounds, Wiley.
8. Goldstein, J. et al., Scanning Electron Microscopy and X-Ray Microanalysis, Springer.
9. Williams, D. B. and Carter, C. B., Transmission Electron Microscopy, Springer.
10. Reimer, L., Scanning Electron Microscopy, Springer.
11. Wendlandt, W. W., Thermal Analysis, Wiley-Interscience.
12. Brown, M. E., Introduction to Thermal Analysis: Techniques and Applications, Springer.
13. Wilson, K. and Walker, J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
14. Saferstein, R., Criminalistics: An Introduction to Forensic Science, Pearson Education.
15. Houck, M. M. and Siegel, J. A., Fundamentals of Forensic Science, Academic Press.
16. koog, D. A., Holler, F. J., and Crouch, S. R., Principles of Instrumental Analysis, Cengage Learning.
17. Bard, A. J., and Faulkner, L. R., Electrochemical Methods: Fundamentals and Applications, John Wiley & Sons.
18. Manjunatha, J. G., Forensic Electrochemistry: The Voltammetry for Sensing and Analysis, American Chemical Society.
19. Wolstenholme, R., Jickells, S., and Forbes, S., Analytical Techniques in Forensic Science, John Wiley & Sons.
20. Mendham, J., Denney, R. C., Barnes, J. D., and Thomas, M. J. K., Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education.

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T02B: Advanced Forensic Chemistry – II**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To gain comprehensive knowledge of the properties of ethyl and methyl alcohol, their physiological effects on the human body, and the scientific principles behind detection methods like breath analyzers and colorimetric tests for illicit liquors.
2. To develop proficiency in classifying and analyzing various dyes and pigments, specifically focusing on the detection of non-edible food dyes and the application of Surface Enhanced Raman Spectroscopy (SERS) in bribery and trap cases.
3. To identify the chemical composition of cosmetics and daily consumer items (such as tea, tobacco, and sugars) and learn systematic methods for sample collection and forensic authentication to detect substandard materials.
4. To understand the classification and manufacturing of fertilizers and to apply instrumental and chemical methods to identify common adulterants in agricultural products.
5. To study the forensic issues surrounding toxic chemicals and food adulterants, focusing on their harmful effects, the mechanisms of poison elimination from the body, and the detection of miscellaneous hazardous substances.
6. To bridge the gap between theoretical chemical analysis and legal application, ensuring that the detection and determination of substances meet the rigorous standards required for forensic evidence.

**Course Outcomes:**

1. Analyze the chemical composition of country and illicit liquors to detect adulterants (like methanol and chloral hydrate) and explain the physiological mechanisms of alcohol intoxication and breath analyzer technology.
2. Categorize forensic evidence from dyes and pigments—including those used in bribery "trap" cases—and apply spectroscopic methods to identify prohibited ingredients in cosmetic products.
3. Implement chemical and instrumental techniques to detect adulteration in fertilizers and perform forensic authentication of consumer goods such as precious metals, tobacco, and food staples.
4. Appraise the forensic significance of daily-use harmful chemicals and describe the pharmacokinetics of poison elimination (absorbed vs. unabsorbed) to assist in toxicological investigations.
5. Detect harmful chemical adulterants in food and daily-use items, applying forensic principles to safeguard public health and mitigate the misuse of hazardous substances.

### **Unit I: Analysis of Beverages & Prohibited Substances**

Introduction of alcohol (ethyl alcohol, methyl alcohol) and illicit liquor, Effects of alcohol on body, Alcohol intoxication, Breath Analyser, Country liquor and illicit liquor, Analysis of Beverages: Detection and Determination of ethanol, furfural, organic acids, aldehydes, chloral hydrate, methanol and ethylene glycol in liquors by colour tests

### **Unit II: Dyes, Cosmetics and Pigments**

**Dyes:** Different types of dyes, food dyes (edible and non- edible dyes), Bribery and Trap cases, Surface Enhanced Raman Spectroscopy method of analysis of dyes

**Cosmetics:** Cosmetic products, Ingredients of cosmetic products, Collection and analysis of cosmetics samples

**Pigments:** Introductions, white pigments, Manufacturing process and properties of blue pigment, red pigment, green pigment, yellow pigment.

### **Unit III: Fertilizers and Other Chemicals**

Introduction to fertilizer, different types of fertilizers and classification, substandard and sub-standard adulterated fertilizers, common adulterants, Chemical and instrumental methods of analysis of fertilizers, forensic analysis of consumer items such as gold, silver, tobacco, tea, sugars, acids and alkalis etc.

### **Unit IV: Harmful Chemicals**

Introduction, Harmful effects of daily used chemicals, Toxic chemicals in toxicology, Forensic issues, Elimination of absorbed and unabsorbed poisons, Harmful chemicals used in food adulteration and their detection, Miscellaneous harmful chemicals

### **Suggested Readings:**

1. Modi, J. P. (2020). A textbook of medical jurisprudence and toxicology. LexisNexis.
2. Pillay, V. V. (2017). Textbook of forensic medicine and toxicology. Paras Medical Publisher.
3. Reddy, K. S. N. (2022). The essentials of forensic medicine and toxicology. Jaypee Brothers Medical Publishers.
4. Cazes, J. (2004). Encyclopedia of chromatography. CRC Press.
5. Ferraro, J. R. (2003). Introductory raman spectroscopy. Academic Press.
6. Gennaro, A. R. (2000). Remington: The science and practice of pharmacy. Lippincott Williams & Wilkins.
7. Barel, A. O., Paye, M., & Maibach, H. I. (2014). Handbook of cosmetic science and technology. CRC Press.
8. Soni, P. L. (2014). Textbook of inorganic chemistry. Sultan Chand & Sons.
9. Finar, I. L. (2002). Organic chemistry, volume 2: Stereochemistry and the chemistry of natural products. Pearson Education.
10. Shrivastava, A. K. (2011). A textbook of fertilizers. Bio-Green Books.
11. Tandon, S. N. (2015). Fertilizers and their analysis. CBS Publishers & Distributors.
12. Nielsen, S. S. (2017). Food analysis. Springer International Publishing.
13. Jacobs, M. B. (1958). The chemical analysis of foods and food products. D. Van Nostrand Company.
14. Watson, D. G. (2012). Pharmaceutical analysis: A textbook for pharmacy students and pharmaceutical chemists. Churchill Livingstone.
15. Bell, S. (2012). Forensic chemistry. Pearson.
16. Houck, M. M. (2015). Forensic chemistry. Academic Press.
17. Baselt, R. C. (2017). Disposition of toxic drugs and chemicals in man. Biomedical Publications.
18. Klaassen, C. D. (2018). Casarett & Doull's toxicology: The basic science of poisons. McGraw-Hill Education.
19. Rangappa, K. S. (2012). Forensic chemical analysis. Nirali Prakashan.
20. Sharma, B. R. (2014). Forensic science in criminal investigation and trials. Universal Law Publishing.

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T03B: Advanced Forensic Toxicology – II**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. Identify the major types and sources of food, plant, animal, and miscellaneous poisons, along with their characteristic signs, symptoms, and post-mortem findings.
2. Explain the basic toxicological action and medico-legal significance of commonly encountered poisons, and outline standard procedures for collection, preservation, and analysis of evidentiary materials.
3. Apply appropriate methods for the extraction and isolation of poisons from food, biological, and related evidentiary samples.
4. Interpret clinical manifestations and post-mortem findings to determine the probable type and cause of poisoning.
5. Evaluate the medico-legal implications of poisoning cases and assess the reliability and limitations of preliminary and confirmatory analytical tests.

**Course Outcomes:** On successful completion of this course, students will be able to:

1. Identify the types, sources, and characteristics of food, plant, animal, and miscellaneous poisons, including their signs, symptoms, and post-mortem findings.
2. Explain the toxicological action and medico-legal significance of various poisons, along with standard procedures for the collection and preservation of evidentiary materials.
3. Apply appropriate extraction, isolation, and analytical techniques for the detection of poisons in food and biological samples.
4. Analyze clinical and post-mortem findings to determine the probable nature and cause of poisoning.
5. Evaluate the medico-legal implications of poisoning cases and assess the reliability and limitations of preliminary and confirmatory tests.

**Unit I: Food Poisons**

Introduction, types of food poisoning, signs and symptoms of food poisoning, Collection, preservation, and handling of evidentiary food samples, Extraction and isolation of poisons from food materials and biological specimens, Analysis and detection using colour tests, chromatographic techniques, and instrumental methods.

## **Unit II: Plant Poisons**

Introduction and classification of plant poisons, Nature, fatal dose, fatal period, signs and symptoms, post-mortem findings, medico-legal significance, and detection of common plant poisons: Datura, Abrus precatorius, Nerium oleander, Calotropis gigantea, Gloriosa superba, Ergot, Mushrooms, etc. Analysis by colour tests, chromatographic techniques, and instrumental methods.

## **Unit III: Animal Poisons**

Introduction and classification of animal poisons, Nature, fatal dose, fatal period, signs and symptoms, post-mortem findings, medico-legal significance, and detection of animal poisons such as Cantharides, spiders, snakes, scorpions, etc. Analysis by colour tests, chromatographic techniques, and instrumental methods.

## **Unit IV: Miscellaneous Poisons**

Nature, fatal dose, fatal period, signs and symptoms, post-mortem findings, medico-legal significance, and detection (preliminary and confirmatory tests) of miscellaneous poisons including asphyxiants such as carbon monoxide, carbon dioxide, hydrogen sulphide, nitrous oxides, war gases, etc.

### **Suggested Readings:**

1. Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. J. K. (2000). Vogel's textbook of quantitative chemical analysis. Pearson Education.
2. Reddy, K. S. N., & Murty, O. P. (2022). The essentials of forensic medicine and toxicology. Jaypee Brothers Medical Publishers.
3. Modi, J. P. (2020). Medical jurisprudence and toxicology. LexisNexis Butterworths.
4. Sharma, R. K. (2011). Forensic toxicology: Principles and concepts. Elsevier India.
5. Dunn, J. E. (1987). Poisoning: Toxicology, symptoms, treatments. McGraw-Hill.
6. Klaassen, C. D. (Ed.). (2018). Casarett and doull's toxicology: The basic science of poisons. McGraw-Hill Education.
7. Moffat, A. C., Osselton, M. D., & Widdop, B. (Eds.). (2011). Clarke's analysis of drugs and poisons. Pharmaceutical Press.
8. Sharma, B. R. (2014). Forensic science in criminal investigation and trials. Universal Law Publishing.
9. Saferstein, R. (Ed.). (2020). Forensic science handbook. Pearson Education.
10. Aggarwal, Y. (2021). Forensic toxicology. Elsevier India.
11. Aggrawal, A. (Ed.). (2014). Textbook of forensic medicine and toxicology. Avichal Publishing Company.
12. Mithal, B. M. (2011). A textbook of forensic pharmacy. Vallabh Prakashan.
13. Kulshrestha, S. K. (2013). Food poisoning and food safety. Pointer Publishers.
14. Ravenscroft, P. H. (2012). Plant toxicology. Springer.
15. Gupta, R. (2016). Handbook of poisoning: Diagnosis & treatment. CBS Publishers & Distributors.
16. Bell, S. (2012). Forensic chemistry. Pearson Education.
17. Fry, B. (Ed.). (2015). Animal toxins and venoms. Oxford University Press.
18. Meyer, V. R. (2010). Chromatographic methods in forensic science. Wiley-VCH.
19. Dasgupta, A. (2019). Analytical toxicology: Principles and techniques. Elsevier.
20. Curry, A. (1988). Poison detection in human organs. Charles C. Thomas Publisher.

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T04B: Pharmaceutical and Narcotic Drugs**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. Understand and recall the fundamental principles of pharmacokinetics and pharmacodynamics, including drug absorption, distribution, metabolism, elimination, and dose–response relationships.
2. Identify and classify narcotic drugs and psychotropic substances, with emphasis on their characteristics and toxicological relevance.
3. Explain drug–receptor interactions, signal transduction mechanisms, and factors influencing drug action and variability.
4. Apply appropriate analytical techniques such as TLC, HPLC, GC, UV–Visible, IR, and mass spectrometry for the forensic analysis of narcotic drugs and psychotropic substances.
5. Assess the medico-legal significance of narcotic drugs and psychotropic substances based on toxicological findings, post-mortem evidence, and forensic case studies.
6. Critically evaluate the advantages, limitations, and reliability of various drug analysis methods used in forensic investigations.

**Course Outcomes:**

1. Explain the principles of pharmacokinetics and pharmacodynamics, including drug absorption, distribution, metabolism, elimination, and drug–receptor interactions.
2. Classify narcotic drugs and psychotropic substances and describe their toxicological effects, fatal dose, fatal period, post-mortem findings, and medico-legal significance.
3. Apply appropriate presumptive and instrumental analytical techniques (TLC, HPLC, GC, UV–Visible, IR, and mass spectrometry) for the identification and analysis of narcotic drugs and psychotropic substances.
4. Interpret analytical and toxicological findings in forensic and medico-legal contexts related to drug abuse and poisoning cases.

**Unit I: Pharmacokinetics**

Concept of pharmacokinetics, Active and passive absorption, blood–brain barrier and placental barrier, Routes of drug administration, Processes of drug absorption, distribution, metabolism, and elimination (ADME), Drug bioavailability, bioequivalence, and biological half-life, Evaluation of pharmacokinetic parameters, Time course of drug plasma concentrations after single and repeated administrations, including various multiple dosage regimens.

## **Unit II: Pharmacodynamics**

Concept of pharmacodynamics, Classification of receptors, Drug–receptor interactions and mechanisms of signal transduction, Dose–response relationships, agonists, partial agonists, and antagonists, Factors modifying drug actions, Adverse drug reactions, including side effects, overdose, idiosyncratic and allergic reactions, Teratogenesis and foetal toxicity, Drug interactions and pharmacogenetics.

## **Unit III: Narcotic Drugs and Psychotropic Substances**

Narcotic drugs and psychotropic substances: Introduction and classification, Nature, fatal dose, fatal period, signs and symptoms, post-mortem findings, and medico-legal significance of opium, heroin, stimulants, depressants, hallucinogens, barbiturates, cannabis, and sedatives, Extraction and isolation of drugs from viscera, blood, vomit, urine, and other biological materials.

## **Unit IV: Analysis of Narcotic Drugs and Psychotropic Substances**

Analytical techniques for narcotic drugs and psychotropic substances, Presumptive field tests, colour tests, and microcrystal tests, Chromatographic techniques including TLC, HPLC, and GC, Spectroscopic and instrumental methods such as UV–Visible, IR, and mass spectrometry for the analysis of depressants, stimulants, hallucinogens, barbiturates, cannabis, and sedatives.

### **Suggested Readings:**

1. Goodman, L. S., & Gilman, A. (2018). Goodman & Gilman's the pharmacological basis of therapeutics (13th ed.). McGraw-Hill Education.
2. Katzung, B. G., Trevor, A. J., & Kruidering-Hall, M. (2021). Basic and clinical pharmacology (15th ed.). McGraw-Hill Education.
3. Rang, H. P., Ritter, J. M., Flower, R. J., & Henderson, G. (2020). Rang and Dale's pharmacology (9th ed.). Elsevier.
4. Golan, D. E., Tashjian, A. H., Armstrong, E. J., & Armstrong, A. W. (2017). Principles of pharmacology: The pathophysiologic basis of drug therapy (4th ed.). Wolters Kluwer.
5. Brahmankar, D. M., & Jaiswal, S. B. (2017). Biopharmaceutics and pharmacokinetics: A treatise (3rd ed.). Vallabh Prakashan.
6. Levine, B. (2019). Principles of forensic toxicology (4th ed.). Springer.

7. Negrusz, A., & Cooper, G. (2018). Clarke's analytical forensic toxicology (2nd ed.). Pharmaceutical Press.
8. Klaassen, C. D. (2019). Casarett and Doull's toxicology: The basic science of poisons (9th ed.). McGraw-Hill Education.
9. Clarke, E. G. C. (2011). Isolation and identification of drugs in pharmaceuticals, body fluids and post-mortem material (2nd ed.). Pharmaceutical Press.
10. Curry, A. S. (2014). Poison detection in human organs. Charles C Thomas Publisher.
11. Vij, K. (2018). Textbook of forensic medicine and toxicology: Principles and practice (6th ed.). Elsevier India.
12. Reddy, K. S. N., & Murty, O. P. (2017). The essentials of forensic medicine and toxicology (33rd ed.). Jaypee Brothers Medical Publishers.
13. Gupta, P. K. (2018). Fundamentals of toxicology: Essential concepts and applications (2nd ed.). Academic Press (Elsevier).
14. Kokate, C. K. (2010). Textbook of forensic pharmacy. Nirali Prakashan.
15. Mohanta, G. P. (2023). Textbook of forensic pharmacy. PharmaMed Press.
16. Baggi, T. R., & Kumar, S. (2023). Essentials of forensic analytical toxicology. CRC Press.
17. Mule, S. J., Casella, G. A., & Pesce, A. J. (2017). Immunoassays for drugs of abuse. CRC Press.
18. Greaves, J., & Roboz, J. (2014). Mass spectrometry for the novice. CRC Press.
19. Hofmann, F. G. (2016). A handbook on drug and alcohol abuse: The biomedical aspects. Oxford University Press.
20. Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. J. K. (2014). Vogel's textbook of quantitative chemical analysis (6th ed.). Pearson Education.
21. Sun, R. (2016). Handbook of analytical toxicology. CRC Press.
22. Aggrawal, A. (Ed.). (2014). Textbook of forensic medicine and toxicology. Avichal Publishing Company.

## M. Sc. Forensic Science Semester - IV

### DSC: MFS4P01B: Practical - I

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 02 60 Lectures/Semester

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#### Course Objectives:

The objectives of the DSC Practical course are to:

1. Provide hands-on training in classical and instrumental analytical techniques used in forensic chemistry and toxicology.
2. Develop practical skills for the detection, identification, separation, and estimation of drugs, poisons, pesticides, metals, and toxins encountered in forensic casework.
3. Familiarize learners with chromatographic techniques (TLC, GC, HPLC, paper and column chromatography) for qualitative and quantitative forensic analysis.
4. Train students in the application of spectroscopic and spectrophotometric methods (UV-Visible, IR, and FTIR) for forensic examinations.

#### Course Outcomes:

On successful completion of this DSC Practical course, the learner will be able to:

1. Apply chromatographic techniques (TLC, GC, HPLC, paper and column chromatography) for the separation and identification of drugs, poisons, pesticides, and forensic samples.
2. Perform spectrophotometric and colorimetric analyses for the determination of toxic metal and non-metal ions in biological and simulated samples.
3. Identify and analyze drugs of abuse and pharmaceuticals, including barbiturates, benzodiazepines, amphetamines, anabolic steroids, and phenolphthalein, using instrumental methods.
4. Detect and estimate pesticides, metallic poisons, plant toxins, and animal/insect toxins in forensic exhibits.

#### Practical: (Minimum of 08 has to be completed)

1. TLC, GC analysis of anabolic steroids.
2. TLC, UV- Visible, HPLC Analysis of phenolphthalein in various cases.
3. Analysis of alcohol content in the sample by derivatization into known organic compounds and its analysis by GC, HPLC.
4. Determination of Mercury in biological materials by spectrophotometry.
5. Analysis of animal and insect toxins. (2)
6. To study the parathion of metal ions by paper chromatography. (2)
7. TLC, GC analysis of barbiturates, benzodiazepines, and amphetamines. (2)
8. Detection and identification of pesticide in a given formulation by colour test, TLC and

UV-Visible spectrometer. (2)

9. Detection of metallic poisons in food stuff (simulated samples). (2)
10. Spectrophotometric / Colorimetric determination of toxic metal ions. (2)
11. Spectrophotometric / Colorimetric determination of non-metal ions. (2)
12. Extraction of different metals from viscera, urine, blood and other biological samples. (2)
13. Estimation of paints and pigments by spectrophotometry (UV, FTIR). (2)
14. Comparison of polythene films by IR spectrophotometry.
15. Separation of sample of forensic interest by column chromatography as a separation technique. (2)
16. Analysis of viscera for volatile poisons (Organic and Inorganic). (2)
17. Analysis of non-metallic (anionic) poisons in viscera. (2)
18. Chemical analysis of explosion residues.
19. Analysis of petroleum product by chemical and instrumental methods.
20. Analysis of Plant poisons using TLC.
21. Extraction of organic poison from biological material by using solvent extraction technique.
22. Extraction of metallic poisons from biological materials by dry ashing.

**M. Sc. Forensic Science Semester - IV**  
**DSE: MFS4T05B: Analytical Chemistry -II**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To understand the fundamental principles of analytical chemistry, including precise sampling techniques, error minimization, and the rigorous presentation of experimental data using significant figures.
2. To develop proficiency in assessing soil composition and water quality by measuring critical parameters such as pH, alkalinity, and dissolved oxygen (DO).
3. To identify the chemical ingredients in personal care products and apply forensic methodologies to analyze substances like antiperspirants and deodorants for specific metallic and acidic content.
4. To understand food preservation techniques and gain practical skills in identifying harmful adulterants in common household staples like spices, milk, and oils.
5. To integrate chemical analysis techniques into the context of forensic science, ensuring that evidence from environmental, cosmetic, and food samples is scientifically sound.
6. To align chemical expertise with the safety of humanity and the environment by identifying contaminants and ensuring the integrity of essential resources.

**Course Outcome:** By the end of this course, the learners would be able to:

1. Identify and recall the basic principles and techniques of analytical chemistry, including the types of errors in chemical analysis, methods of sampling, and significance of accuracy and precision.
2. Explain the principles behind various analytical methods and techniques
3. Apply appropriate analytical techniques to assess the quality and safety of water, soil, cosmetics, and food samples.
4. Analyze experimental results with respect to accuracy, precision, and significant figures.
5. Critically evaluate the effectiveness and limitations of various analytical methods in the context of forensic science.

**Unit I: Analytical Chemistry**

Introduction to Analytical Chemistry, Analytical Methods, Concept of Sampling, Errors in Chemical Analysis, Accuracy and Precision, Presentation of Experimental Results, Concept of Significant Figures, Role of analytical chemistry in forensic science.

## **Unit II: Water and Soil Analysis**

Introduction, Composition of Soil, Significance of Soil Analysis, Interpretation of Soil pH, Determination of pH of Soil, Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods, Determination of pH, acidity and alkalinity of a water sample, Determination of dissolved oxygen (DO) of a water sample.

## **Unit III: Analysis of Cosmetics**

Introduction, Types of cosmetic products, Ingredients of cosmetic products, Antiperspirants and Deodorants, Collection and analysis of cosmetics samples, Analysis of Deodorants and Antiperspirants: Al, Zn, Boric Acid, Chloride, Sulfate, Forensic Significance.

## **Unit IV: Analysis of Food**

Introduction to Food, Nutritional value of foods, ideas about food processing, food preservation, and adulteration, Identification of adulterants in some everyday food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder, pulses, milk, oil, etc., Analysis of preservatives and coloring material.

### **Suggested Readings:**

1. Christian, G. D., Dasgupta, P., & Schug, K. (2013). Analytical chemistry. John Wiley & Sons.
2. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of analytical chemistry. Cengage Learning.
3. Harris, D. C. (2015). Quantitative chemical analysis. W. H. Freeman and Company.
4. Miller, J. N., & Miller, J. C. (2018). Statistics and chemometrics for analytical chemistry. Pearson Education.
5. Jackson, M. L. (2005). Soil chemical analysis. Parallel Press.
6. Maiti, S. K. (2004). Handbook of methods in environmental studies: Vol. 1. Water and wastewater analysis. ABD Publishers.
7. De, A. K. (2017). Environmental chemistry. New Age International Private Limited.
8. Rice, E. W., Baird, R. B., & Eaton, A. D. (Eds.). (2017). Standard methods for the examination of water and wastewater. American Public Health Association.
9. Balsam, M. S., & Sagarin, E. (Eds.). (2008). Cosmetics: Science and technology. Wiley-Interscience.
10. Barel, A. O., Paye, M., & Maibach, H. I. (2014). Handbook of cosmetic science and technology. CRC Press.
11. Butler, H. (Ed.). (2000). Poucher's perfumes, cosmetics, and soaps. Kluwer Academic Publishers.
12. Sharma, P. P. (2010). Cosmetics: Formulation, manufacturing and quality control. Vandana Publications.
13. Nielsen, S. S. (2017). Food analysis. Springer International Publishing.
14. Pearson, D. (1976). The chemical analysis of foods. Churchill Livingstone.
15. Srilakshmi, B. (2018). Food science. New Age International Private Limited.
16. Manay, S. N., & Shadaksharaswamy, M. (2020). Foods: Facts and principles. New Age International Private Limited.
17. Nanda, B. B., & Tiwari, R. K. (2001). Forensic science in India: A vision for the twenty-first century. Select Publishers.
18. Saferstein, R. (2017). Criminalistics: An introduction to forensic science. Pearson.
19. James, S. H., Nordby, J. J., & Bell, S. (2014). Forensic science: An introduction to scientific and investigative techniques. CRC Press.
20. Popli, P. (2016). A textbook of pharmaceutical analysis. CBS Publishers & Distributors.

## M. Sc. Forensic Science Semester - IV

### DSE: MFS4P02B: Practical - II

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 02    60 Lectures/Semester

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#### Course Objectives:

The objectives of the DSE Practical course are to:

1. Provide practical exposure to classical analytical chemistry techniques applied to environmental, food, and consumer product analysis.
2. Develop skills in quantitative and qualitative chemical analysis using titrimetric, gravimetric, potentiometric, and spectrophotometric methods.
3. Train students in the analysis of water quality parameters, including pH, acidity, alkalinity, and dissolved oxygen.
4. Enable learners to perform complexometric titrations for the determination of metal ions in soil, talcum powder, and other samples.

#### Course Outcomes:

On successful completion of this DSE Practical course, the learner will be able to:

1. Measure and interpret pH values of soil and water samples using both colorimetric and electrometric methods.
2. Determine acidity, alkalinity, and dissolved oxygen of water samples using standard analytical procedures.
3. Estimate calcium and magnesium ions in soil and related samples using complexometric titration techniques.
4. Quantitatively analyze food preservatives such as benzoic acid and sorbic acid in food items.

#### Practical: (Minimum of 08 has to be completed)

1. Measurement of soil pH using a potentiometer.
2. Estimation of Calcium and Magnesium Ions as Calcium Carbonate by Complexometric Titration
3. Determination of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions concentrations in soil as  $\text{CaCO}_3$  by complexometric titration method.
4. Determination of water pH (i) using pH paper (colorimetrically) and (ii) using pH meter (electrometrically). Acidity of Water
5. Determination of the acidity of water sample.
6. Determination of hydroxide, carbonate and bicarbonate alkalinity of water sample.
7. Determination of dissolved oxygen (DO) in water sample using Winkler's (azide

modification) method.

8. Qualitative and quantitative estimation of benzoic acid in food items.
9. Qualitative and quantitative estimation of sorbic acid in food items.
10. Determination of Aluminium (Al) and zinc (Zn) in deodorants by gravimetric method
11. Determination of chloride ( $\text{Cl}^-$ ) in deodorants by gravimetric method.
12. Determination of sulphate ( $\text{SO}_4^{2-}$ ) in deodorants by gravimetric method.
13. Determination of boric acid ( $\text{H}_3\text{BO}_3$ ) in deodorants and antiperspirants by ion-exchange method.
14. Determination of Constituents of Talcum Powder: Magnesium Oxide, Calcium Oxide, Zinc Oxide and Calcium Carbonate by Complexometric Titration
15. Determination of magnesium oxide (MgO) in talcum powder by complexometric titration method.
16. Determination of zinc oxide (ZnO) in talcum powder by complexometric titration method.
17. Quantitative determination of iron content of a commercially available vitamin tablet using UV-Vis spectrophotometry.

# **Specialization – III**

## **Forensic Biology and Serology**

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T01C: Forensic Anthropology and Odontology**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To provide knowledge of human skeletal biology, anthropology, and odontology with forensic applications.
2. To train students in personal identification through skeletal, dental, and craniofacial analyses.

**Course Outcomes:**

1. Explain the scope of anthropology, fossil formation, dating techniques, and their forensic significance.
2. Demonstrate methods of skeletal and dental age, sex, race, and stature estimation.
3. Differentiate human from non-human skeletal remains and identify trauma types.
4. Apply forensic odontology methods including dental charting, bite mark analysis, and comparison of ante- and post-mortem dental records.
5. Utilize anthropological and odontological methods for identification in mass disasters and medico-legal cases.

**Unit I:**

- Introduction to Theories of Anthropology, The scope of anthropology-Paleoanthropology, skeletal biology and human osteology.
- The scope of anthropology- Paleopathology and Bio-archeology, Forensic Anthropology.
- Fossil formation, taphonomy, Relative dating techniques, Chronometric dating techniques.
- Role of anthropology in mass disaster, Physical Anthropology and its forensic aspects.

**Unit II:**

- Bio-archeology- Field recovery methods, Laboratory processing, curation and chain of custody.
- Age at death, sex, ancestry, height and weight, premortem injury and disease, taphonomy, peri-mortem trauma, post-mortem trauma.
- Identification and forensic Anthropology: Time since death, ante-mortem records and positive IDs, Facial reconstruction.
- DNA Kinship and identity.

### **Unit III:**

- Personal Identification of Living and Dead- Identification through somatometric and somatoscopic observation (nails, occupation marks, scars, tattoo marks and deformities, handwriting and mannerisms).
- Skeletal age (Earlier years): Prenatal ossification, Postnatal appearance, union of centers of ossification, Differences due to race.
- Skeleton age (Later years): Cranial suture closure, pubic symphysis; Calculation of stature of long bones- Studies on stature reconstruction in various population groups; Uses of fragmentary long bones in stature reconstruction.
- Racial differences in human skeleton; distinguishing humans from other nonhuman skeletal remains. Sexing skeletal Remains: General consideration and age factors, Sex differences in skull, Pelvis and long bones.

### **Unit IV:**

- Determination of age from teeth using various methods, Dental anomalies and their role in Personal Identification.
- Dental Charting, Dental record, Comparison of Ante-mortem and postmortem dental records.
- Bite marks- Types & forensic importance, Collection and preservation of samples, analysis of Bite marks, and presentation of bite mark evidences incourt of law.
- Role of Forensic Odontology in mass disaster victim identification.

### **Suggested readings:**

1. Forensic Anthropology: Current Methods and Practice – Angi M. Christensen, Nicholas V. Passalacqua & Eric J. Bartelink; Academic Press.
2. Introduction to Forensic Anthropology – Steven N. Byers; Routledge.
3. Forensic Anthropology: An Introduction – MariaTeresa A. Tersigni-Tarrant & Natalie R. Shirley; CRC Press.
4. Essentials of Forensic Anthropology – Sandra K. Westmont; Routledge.
5. The Human Bone Manual – Tim D. White & Pieter A. Folkens; Academic Press.
6. Human Osteology – Tim D. White, Michael T. Black & Pieter A. Folkens; Academic Press.
7. Skeletal Biology of Past Peoples – Clark Spencer Larsen; Routledge.
8. Forensic Taphonomy – William D. Haglund & Marcella H. Sorg; CRC Press.
9. Forensic Odontology: Principles and Practice – Thomas J. David & David R. Senn; CRC Press.

10. Manual of Forensic Odontology – David R. Senn & Paul G. Stimson; CRC Press.
11. Dental Autopsy: Identification and Mass Disaster Management – Jeffrey A. Elias; Charles C Thomas Publisher.
12. Craniofacial Identification – Caroline Wilkinson; Cambridge University Press.
13. The Skull: Functional and Evolutionary Mechanisms – James Hanken & Brian K. Hall; University of Chicago Press.
14. Age Estimation in the Living – Sue Black, Jason Payne-James & Anthony Busuttill; Wiley-Blackwell.
15. Forensic Human Identification – Tim Thompson & Suzanne Black; CRC Press.
16. Handbook of Forensic Anthropology and Archaeology – Soren Blau & Douglas Ubelaker; Routledge.
17. Ancestry Determination in Forensic Anthropology – George W. Gill & Rick A. Spritz; CRC Press.
18. Forensic Bite Mark Identification – Robert B.J. Dorion; CRC Press.
19. Advances in Forensic Human Identification – Xanthe Mallett, Teri Blythe & Rachel Berry; CRC Press.
20. Biological Anthropology and Prehistory – Patricia C. Rice & Norah Moloney; Routledge.

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T02C: Wildlife and Environmental Forensics**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To provide an understanding of wildlife crime investigation and environmental forensic applications.
2. To develop competence in analytical methods for detection of pollutants, toxins, and wildlife crime evidence.

**Course Outcomes:**

1. Identify protected/endangered species and explain wildlife crime methods and conservation strategies.
2. Apply forensic methods for recovery and analysis of wildlife evidence (e.g., reptile scales, poaching scenes).
3. Describe environmental pollutants (mercury, arsenic, pesticides, asbestos, PAHs) and their forensic analysis.
4. Perform environmental monitoring using BOD, COD, biosensors, and environmental impact assessment.
5. Demonstrate applications of GIS, GPS, and remote sensing in wildlife and environmental forensics.
6. Critically evaluate international standards (ISO 14000) and policies for sustainable environmental management.

**Unit I:**

- Wildlife Forensic: Protected and endangered species of animals and plants, Sanctuaries and their importance.
- Types of wildlife crimes; Different methods of killing and poaching of wildlife animals,
- Wild animals as pharmacopoeias.
- Introduction to Wildlife telemetry: Transmitters (Antenna, Power source) Transmitter attachments (General protocol, collars etc.).
- Remote sensing, GIS (Geographical Information system) and GPS (Geographical positioning system) in Wildlife conservation.

## **Unit II:**

- Wildlife trade (Illegal wildlife trade, Global and Indian scenario, Major articles in wildlife trade); Organizations working in conservation of wildlife.
- Wildlife Forensic: Recovering evidence at poaching scenes.
- Locating the burial: Anomalies on the surface.
- Reptile scale morphology basics,
- Conventional and Modern Methods of wildlife material identification.

## **Unit III:**

- Environmental Forensics: Introduction to Environmental Forensics.
- Mercury- Natural and anthropogenic sources, detecting mercury in indoor environment and forensic aspects; Asbestos sources and detection in air, water, fibres etc.
- Arsenic sources, compounds, analytical methods and forensic aspects.
- Pesticides- Types, analytical testing and forensic techniques; Polycyclic aromatic hydrocarbons (PAHS)- sources, types and analytical techniques.

## **Unit IV:**

- Environment and Ecosystems: Ecosystem characteristics structure and function.
- Xenobiotic and recalcitrance, Introduction to BOD and COD.
- Use of biosensors to determine the quality of the environment, Introduction and scope of environmental management.
- Basic concepts of sustainable development, Environmental Impact Assessment (EIA).
- International organization for standardization (ISO), ISO 14000 standards and certification.

## **Suggested readings:**

1. Wildlife Forensics: Methods and Applications – Jane E. Huffman & John R. Wallace; Wiley-Blackwell.
2. Wildlife DNA Analysis: Applications in Forensic Science – Adrian Linacre & Shanan Tobe; Wiley-Blackwell.
3. Forensic Ecology Handbook – Julie Roberts & Nigel Marston; Wiley-Blackwell.
4. Forensic Entomology: International Dimensions and Frontiers – Jeffery K. Tomberlin & M. Eric Benbow; CRC Press.
5. Forensic Botany: Principles and Applications – Heather Miller Coyle; CRC Press.
6. Conservation Biology – Andrew S. Pullin; Cambridge University Press.

7. Environmental Forensics: Principles and Applications–Robert D. Morrison & Brian L. Murphy; Academic Press.
8. Introduction to Environmental Forensics – Brian L. Murphy & Robert D. Morrison; Academic Press.
9. Wildlife Forensics: Principles and Practice – Steven Busse; CRC Press.
10. Toxicological Chemistry and Biochemistry – Stanley E. Manahan; CRC Press.
11. Pesticide Toxicology and International Regulation–Timothy Marrs & Bryan Ballantyne; Wiley.
12. Mercury in the Environment: Pattern and Process – Michael S. Bank; University of California Press.
13. Arsenic in the Environment – Jerome O. Nriagu; Wiley.
14. Forensic Geoscience: Principles and Applications – Kenneth Pye & Deborah J. Croft; Geological Society.
15. Principles of Wildlife Forensics – Samuel Wasser; Elsevier.
16. Conservation and Wildlife Crime – Rosaleen Duffy; Routledge.
17. Remote Sensing and GIS for Natural Resource Management – M.L. Victor; Springer.
18. Applied Environmental Forensics – Edward A. Stroo et al.; CRC Press.
19. Ecotoxicology: Effects of Pollutants on the Natural Environment – Colin Walker; CRC Press.
20. Environmental Impact Assessment – Larry W. Canter; McGraw-Hill.
21. Forensic Anthropology: Current Methods and Practice – Angi M. Christensen, Nicholas V. Passalacqua & Eric J. Bartelink; Academic Press.

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T03C: DNA Fingerprinting- II**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To provide advanced knowledge of DNA fingerprinting methods, population genetics, and databasing.
2. To train students in interpretation of DNA evidence and emerging technologies in DNA profiling.

**Course Outcomes:**

1. Perform advanced DNA profiling techniques including STRs, SNPs, mtDNA, and NGS applications.
2. Explain population genetics principles (Hardy–Weinberg equilibrium, allele frequency, probability of match).
3. Interpret DNA evidence considering issues of degradation, contamination, and multiple contributors.
4. Evaluate evidence using statistical parameters like likelihood ratio, paternity index, and probability of exclusion.
5. Discuss databasing, quality assurance, and legal/ethical issues in forensic DNA databanks.
6. Apply bioinformatic tools for analysis and interpretation of genetic data.

**Unit I:**

- Advanced techniques in Human DNA profiling: Uni-parentally inherited genetic markers in ethnic and geographical origin detection.
- DNA Profiling Kits (Easy DNA, Pro-filerPlus Kit), DNA fingerprinting of degraded samples, Next-Generation Sequencing (NGS).
- SNP microarray for supplementary paternity testing, Drug-DNA interaction.
- Mitochondrial DNA analysis in Humans (DNA multi-reverse parental analysis, cytochrome b analysis).
- eDNA Personal Effects and DNA analysis (sources and problems).

## **Unit II:**

- Population genetics- Allele frequency, Genotype Frequency, Heterozygosity, Hardy–Weinberg Principle. Testing for HW Proportions of Population Databases, Probability of Match.
- Genotypes- Profile Probability and Likelihood Ratio, Haplotypes- Mitotypes Observed in Database and Not Observed in Database.
- Goodness of fit with HWE, Cumulative frequency distribution, Probability of match and discrimination, Power of exclusion, Evidence evaluation.
- Paternity index, Likelihood of paternity / probability of paternity.

## **Unit III:**

- Forensic DNA evidence interpretation: Interpretation of DNA typing results-Complicating Factors (Multiple contributors, degradation, and extraneous substances),
- System-specific Interpretational Issues (RFLP, PCR systems).
- Assessing the strength of evidence: Determination of Genetic Concordance, Evaluation of Results, Frequency Estimate Calculations,
- Population Substructure (Estimating Frequencies- Continuous Allele Systems (RFLP), Discrete Allele Systems, Correction Factors, Relatives, Counting Method, Error Rates),

## **Unit IV:**

- The DNA Databank and Quality Assurance– Premise of a data bank;
- Elements of a successful databank – legislation, collection of samples, analysis of samples;
- Transformation of analyzed data into a database
- Quality Assurance– Certification and Accreditation, SWGDAM,
- NRC I and NRC II.

## **Suggested readings:**

1. Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers – John M. Butler; Academic Press.
2. Fundamentals of Forensic DNA Typing – John M. Butler; Academic Press.
3. Advanced Topics in Forensic DNA Typing: Interpretation – John M. Butler; Academic Press.
4. DNA Typing in Forensic Medicine: A Laboratory Guide – Jan Lindstedt; CRC Press.

5. DNA Technology in Forensic Science – National Research Council; National Academies Press.
6. Population Genetics and Microevolutionary Theory – Alan R. Templeton; Wiley-Blackwell.
7. An Introduction to Genetic Analysis – Anthony J.F. Griffiths et al.; W.H. Freeman.
8. Human Molecular Genetics – Tom Strachan & Andrew Read; Garland Science.
9. Molecular Biology of the Gene – James D. Watson et al.; Pearson.
10. Molecular Biology of the Cell – Bruce Alberts et al.; Garland Science.
11. DNA Evidence and Forensic Science – David Lazer; MIT Press.
12. Genetic Data Analysis for Plant and Animal Breeding – Fikret Isik et al.; Springer.
13. Mitochondrial DNA: Methods and Protocols – Humana Press.
14. Forensic DNA Applications: An Interdisciplinary Perspective – Dragan Primorac & Moses Schanfield; CRC Press.
15. The Science of Forensic DNA Profiling – Prof. Dr. Jae-Chun Ryu; Springer.
16. Next-Generation DNA Sequencing Informatics – Stuart M. Brown; Cold Spring Harbor Laboratory Press.
17. Handbook of Forensic Genetics – Victor A. McKusick; Elsevier.
18. Statistical Genetics and Genomics – Russell L. Malmberg; Springer.
19. Principles of Population Genetics – Daniel L. Hartl & Andrew G. Clark; Sinauer Associates.
20. Bioinformatics: Sequence and Genome Analysis – David W. Mount; Cold Spring Harbor Laboratory Press.

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T04C: Thanatology and Forensic Pathology**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To impart knowledge of medico-legal autopsies, causes of death, and forensic pathology of injuries and poisons.
2. To develop competence in medico-legal interpretation of deaths, trauma, and toxicological cases.

**Course Outcomes:**

1. Explain changes after death, types of natural/unnatural deaths, and medico-legal implications.
2. Demonstrate medico-legal aspects of sexual offences, abortion, infanticide, and child abuse.
3. Differentiate between antemortem and post-mortem injuries and estimate injury age.
4. Perform autopsy procedures including preservation of viscera, fluids, and toxicological samples.
5. Describe medico-legal aspects of poisons (animal, plant, chemical) and interpret signs and symptoms.
6. Apply forensic pathology knowledge in courts of law for expert testimony.

**Unit I:**

- Introduction of Forensic pathology & thanatology; Cause, manner, characteristics and signs of death, Natural and unnatural death,
- Changes after death (Immediate, Early, postmortem)
- Personal Identity of the Dead; identification & Examination of Decomposed/Mutilated Bodies,
- Deaths by poisoning; Signs and symptoms of poisoning- Acute & Chronic
- Asphyxial Deaths (Hanging, Strangulation, Suffocation, Drowning,)

**Unit II**

- Sexual Offences I (Natural-Rape, Incest, Adultery); Sexual Offences Unnatural
- Abortion (Natural and Induced)
- Infanticide and Child Abuse, Medico-legal aspects of female feticide,
- Impotence and Sterility, medico-legal aspect of sterilization
- Artificial insemination, test-tube baby, surrogate motherhood,

### Unit-III

- Definitions of medico-legal and clinical/pathological autopsies; Objectives, procedures, formalities of medico-legal autopsies;
- Preservation of articles of importance, during autopsy; Preservation of body fluids & viscera in suspected poisoning.
- Injury, Types of Injury/wounds; Mechanical injuries or wounds:
- Definition, classification; Description of blunt force, sharp force and firearm injuries.
- Medico-legal aspects of injuries, differences between antemortem and post-mortem injuries, estimation of age of different types of injuries.

### Unit-IV

Types of poisons, diagnosis, Mode of action, and medico-legal aspects of:

- Animal poisons: Snake and scorpion bites.
- Deliriant: Dhatura, Cannabis. Somniferous agents: Opium.
- Asphyxiant poisons: Carbon monoxide, Carbon dioxide, Methane and cyanides.
- Cardiac poisons: a) *Cerberathevetia* and *Nerium odorum*,
- Food poisoning by bacteria (*Shigella*)

### Suggested readings:

1. Forensic Pathology – Vincent J.M. DiMaio & Dominick DiMaio; CRC Press.
2. Spitz and Fisher's Medicolegal Investigation of Death – Werner Spitz; Charles C Thomas Publisher.
3. Knight's Forensic Pathology – Pekka Saukko & Bernard Knight; CRC Press.
4. Simpson's Forensic Medicine – Jason Payne-James et al.; CRC Press.
5. Essentials of Forensic Medicine and Toxicology – K.S. Narayan Reddy; Jaypee Brothers.
6. Parikh's Textbook of Medical Jurisprudence, Forensic Medicine and Toxicology – C.K. Parikh; CBS Publishers.
7. Review of Forensic Medicine and Toxicology – Gautam Biswas; Jaypee Brothers.
8. Fundamentals of Forensic Medicine and Toxicology – Anil Aggrawal; Avichal Publishing.
9. Principles of Forensic Medicine and Toxicology – Rajesh Bardale; Jaypee Brothers.

10. Color Atlas of Forensic Pathology – Jay Dix; CRC Press.
11. Atlas of Forensic Pathology – Pekka Saukko; CRC Press.
12. Medicolegal Investigation of Death – Charles S. Hirsch et al.; CRC Press.
13. Pathology of Trauma – D.J. Gee & J. Dixon; Hodder Arnold.
14. The Essentials of Forensic Pathology – Gilbert Forbes; Pergamon.
15. Clinical Forensic Medicine: A Physician's Guide – Margaret M. Stark; Springer.
16. Forensic Medicine: Fundamentals and Perspectives – Reinhard B. Dettmeyer; Springer.
17. Forensic Toxicology: Principles and Concepts – Barry Levine; CRC Press.
18. Handbook of Forensic Medicine – Burkhard Madea; Wiley-Blackwell.
19. Color Atlas of Forensic Medicine and Pathology – Charles C. Hirsch; CRC Press.
20. Practical Forensic Medicine – V.V. Pillay; Paras Medical Publishers.

**M. Sc. Forensic Science Semester - IV**

**DSC: MFS4P01C: Practical - I**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02    60 Lectures/Semester**

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**Course Objectives:**

1. To provide hands-on training in forensic biological and serological techniques.
2. To develop skills in forensic anthropology, toxicology, odontology, and DNA analysis.
3. To apply laboratory methods for forensic identification and environmental analysis.
4. To expose students to professional forensic and allied laboratory environments.

**Course Outcomes:**

1. Extract and analyze plant toxins and biological metabolites.
2. Perform bite mark analysis and dental charting for personal identification.
3. Estimate age, stature, race, and time since death from skeletal data.
4. Extract DNA from degraded samples and interpret STR profiles.
5. Analyze environmental samples such as water for BOD estimation.
6. Apply wildlife forensic methods for crime scene management and evidence collection.

**Practical: (Minimum of 08 has to be completed)**

1. To perform extraction and purification of Dhatura/Nerium metabolites.
2. To perform bite mark analysis on collected samples.
3. To perform dental charting from bitemark.
4. To perform stature estimation from long bones and fragmentary bones.
5. To perform age estimation from various bones.
6. To perform racial analysis from various bones.
7. To calculate time since death from cadaver.
8. To perform extraction of DNA from degraded samples.
9. To perform Interpretation of STR profile.
10. To perform BOD analysis from water samples.
11. To perform Wildlife crime scene management and evidence collection.
12. Visit to autopsy center at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Center, Biodiversity and wildlife Center.

## M. Sc. Forensic Science Semester - IV

### DSE: MFS4T05C: Recombinant DNA Technology and Bioinformatics

Max. Marks: 60 (Theory) + 40 (Internal)

Credits: 02 30 Lectures/Semester

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#### Course Objectives:

1. To provide an understanding of recombinant DNA tools, gene cloning, and bioinformatics applications.
2. To develop analytical skills in sequence analysis, molecular modeling, and protein structure prediction.

#### Course Outcomes:

1. Demonstrate knowledge of enzymes, cloning vectors, and molecular tools used in recombinant DNA technology.
2. Access and utilize biological databases (NCBI, EMBL, DDBJ, PDB, KEGG) for nucleic acid and protein analysis.
3. Perform sequence alignment (BLAST, FASTA, ClustalW) and construct phylogenetic trees.
4. Apply protein structure prediction methods including homology modeling, fold recognition, and ab-initio approaches.
5. Use molecular docking and dynamics for studying protein-ligand interactions.
6. Integrate bioinformatics tools in forensic biology for DNA/protein evidence analysis.

#### Unit- I

- Molecular tools: Polymerase enzymes,
- Nucleic acid modifying enzymes,
- Nucleic acid ligases, Proteases,
- Types of restriction enzymes and their subtypes and application,
- Introduction to Gene cloning vectors: Plasmids; shuttle vectors; phagmids;

#### Unit- II

- General Introduction of Biological Database.
- Types of Biological Database.
- Nucleic acid databases (NCBI, DDBJ, and EMBL).
- Protein databases (Primary, Composite, and Secondary).
- Molecular visualization – use of Rasmol, PDB, and KEGG.

### **Unit- III**

- Sequence Alignments and Visualization,
- Local alignment and Global alignment (algorithm and example),
- Pairwise alignment (BLAST and FASTA Algorithm);
- Multiple sequence alignment (Clustal W algorithm).
- Introduction to phylogenetic trees.

### **Unit- IV**

- Protein Tertiary structure prediction methods: Homology Modeling,
- Fold Recognition, Ab- initio Method,
- Protein folding,
- Molecular Dynamics of Protein,
- Molecular Docking of Protein,

### **Suggested readings:**

1. Bioinformatics An Introduction by Ramsden Jeremy, Springer 2021, ISBN: 9783030456078
2. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press, ISBN: 978-087969712-9
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis & B.F. Francis Ouellette; Wiley-Blackwell.
4. Bioinformatics: A practical guide to the analysis of genes and proteins by Baxevanis A.D. and Ouellette B.F. John Wiley & Sons, New York, ISBN: 978-0-471-47878-2
5. Computational Genomics with R – Altuna Akalin; CRC Press.
6. Computational Structural Biology: Methods and Applications – Torsten Schwede & Manny A. Marti-Renom; World Scientific.
7. David W Mount, Bioinformatics sequence and genome analysis, CBS publishers & Distributors 2nd Ed. (2004) ISBN 978-087969712-9
8. Essential Bioinformatics by Jin Xiong, Cambridge University Press, ISBN-13 978-0-51116815-4 eBook; 978-0-521-84098-9 hardcopy
9. From Genes to Genomes: Concepts and Applications of DNA Technology – Jeremy W. Dale & Malcolm von Schantz; Wiley-Blackwell.
10. Genomes – T.A. Brown; Garland Science.
11. Introduction to Genomics – Arthur Lesk; Oxford University Press.

12. Introduction to Protein Structure – Carl Branden & John Tooze; Garland Science.
13. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick et al.; ASM Press.
14. Molecular Cloning: A Laboratory Manual – Joseph Sambrook & David W. Russell; Cold Spring Harbor Laboratory Press.
15. Molecular Docking: Methods, Applications, and Perspectives – Dimitrios Vlachakis; Humana Press.
16. Multiple Sequence Alignment Methods – David J. Russell (Ed.); Springer.
17. Phylogenetics: Theory and Practice of Phylogenetic Systematics – E.O. Wiley & Bruce S. Lieberman; Wiley-Blackwell.
18. Principles of Gene Manipulation and Genomics – Sandy B. Primrose & Richard M. Twyman; Wiley-Blackwell.
19. Protein Bioinformatics: From Sequence to Function – D. Frishman & A. Valencia; Springer.
20. Protein Structure Prediction: Methods and Protocols – Daisuke Kihara; Humana Press.
21. Recombinant DNA: Genes and Genomes – A Short Course – James D. Watson et al.; W.H. Freeman.
22. Structural Bioinformatics – Jenny Gu & Philip E. Bourne; Wiley-Blackwell.

**M. Sc. Forensic Science Semester - IV**

**DSE: MFS4P02C: Practical - II**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02    60 Lectures/Semester**

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**Course Objectives:**

1. To introduce students to biological and forensic databases.
2. To develop skills in sequence retrieval, submission, and analysis.
3. To train students in sequence alignment, BLAST, and phylogenetic analysis.
4. To visualize and predict protein structures using bioinformatics tools.
5. To apply bioinformatics methods in forensic and molecular biology contexts.

**Course Outcomes:**

1. Access and retrieve data from biological and forensic databases.
2. Perform sequence alignment and similarity searches using BLAST.
3. Visualize and predict protein secondary and tertiary structures.
4. Construct phylogenetic trees using bioinformatics tools.
5. Design primers and simulate restriction digestion in silico.
6. Interpret STR and protein domain data for forensic applications.

**Practical: (Minimum of 08 has to be completed)**

1. Assessing the nucleic acid databases (NCBI/DDBJ/EMBL)
2. To access the FASTA sequence retrieval from DNA databases.
3. To perform the submission of sequence to databases (Nucleic acid/protein).
4. To access the protein structure retrieval from protein databases.
5. 3-Dimensional structure visualization of protein using RASMOL from protein databases.
6. To perform the pairwise sequence alignment of nucleic acid/protein sequences.
7. To perform the multiple sequence alignment of nucleic acid/protein sequences.
8. To perform BLAST analysis.
9. Construction of phylogenetic tree using bioinformatics tools.
10. To perform the restriction digestion using bioinformatic tools.
11. To perform the DNA primer study using bioinformatics tools.
12. To perform secondary structure prediction of protein using bioinformatics tools.
13. To perform 3-dimensional structure prediction of protein using bioinformatics tools.
14. To study the protein domain databases.
15. To study the STR databases in forensic biology.
16. Visit to Biotechnology / Bioinformatics Center.

# **Specialization – IV**

## **Digital and Cyber Forensic**

**M. Sc. Forensic Science Semester - IV**

**DSC: MFS4T01D: Steganography and Watermarking**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To understand distinct mathematical properties that separate steganography from digital watermarking
2. To enable students to conceptualize watermarking systems as communication channels, specifically focusing on the interaction between encoders, decoders, and the environmental "noise" of the host signal.
3. To provide methodologies for testing how embedded signals endure signal processing attacks, including lossy compression and geometric or volumetric transformations.
4. To illustrate the integration of encryption protocols within embedding processes to safeguard hidden data against unauthorized modification or adversarial forgery.

**Course Outcomes:**

1. Critically evaluate and select the optimal technique- Steganography or Watermarking
2. Develop and deploy fundamental message coding architectures by utilizing Message Vectors and Error Correction Coding (ECC) to maintain data reliability and integrity across various transmission channels.
3. Optimize Embedding via Side Information Leverage Informed Coding and Dirty-Paper Coding strategies to maximize the data payload capacity and perceptual transparency (imperceptibility) of watermarks within host media.
4. Assess System Resilience Quantitatively analyze how watermarking schemes perform when subjected to Volumetric Distortions and Geometric Distortions
5. Diagnose vulnerabilities by identifying critical adversarial attacks and engineer Authentication Protocols- ranging from Exact to Selective- to detect tampering and verify the legitimacy of digital content.

**Unit I:**

Information Hiding, Steganography, and Watermarking, Importance of Digital Watermarking and Steganography, Applications of Watermarking, Applications of Steganography, Properties of Watermarking Systems, Properties of Steganographic and Steganalysis Systems

**Unit II:**

Models of Watermarking: Communication-Based Models of Watermarking, Geometric Models of Watermarking, Modelling Watermark Detection by Correlation, Basic Message Coding: Mapping Messages into Message Vectors, Error Correction Coding

**Unit III:**

Watermarking with Side Information: Informed Embedding, Watermarking Using Side Information, Dirty-Paper Codes

Robust Watermarking: Approaches, Robustness to Volumetric Distortions, Robustness to Temporal and Geometric Distortions

**Unit IV:**

Watermark Security: Security Requirements, Watermark Security and Cryptography, Some Significant Known Attacks

Content Authentication: Exact Authentication, Selective Authentication, Localization, Restoration

**Suggested Readings:**

1. Digital Watermarking and Steganography, Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kauffman
2. Digital Watermarking principles, Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Morgan Kauffman

**M. Sc. Forensic Science Semester - IV**

**DSC: MFS4T02D: Biometrics**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02 30 Lectures/Semester**

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**Course Objectives:**

1. To introduce the principles and operation of various biometric systems.
2. To explore the limitations and standards of biometric data and multi-biometric fusion.
3. To study spoofing vulnerabilities and detection methods, specifically in fingerprinting.
4. To analyze the technical frameworks of face and fingerprint recognition, including feature extraction and matching algorithms.

**Course Outcomes:**

1. Understand the fundamental architecture of a biometric system and evaluate the characteristics of various modalities.
2. Analyze security threats such as spoofing and identify the role of biometrics in forensic investigations like DNA and dental analysis.
3. Implement and compare face recognition techniques using subspace analysis and standard face databases.
4. Demonstrate an in-depth understanding of fingerprint formation, sensing, and the mathematical basis for fingerprint matching.
5. Design a multi-biometric fusion strategy to improve system accuracy and overcome the limitations of unimodal systems.

**Unit I:**

Introduction, Operation of a biometric system, Applications of biometrics, Biometric characteristics, Limitations of biometric systems, Biometric standards, Multibiometric systems

**Unit II:**

Spoof Detection Systems: Introduction, Historical Survey, Fingerprint Case Study.

Forensic science and biometrics - a general contrast, Anthropometry, Fingerprinting, DNA, Voice, Face and Ear, Dental Features, and Handwriting

**Unit III:**

Introduction to Face Recognition, Face Recognition Processing, Analysis in Face Subspaces, Technical Challenges and Solutions, Face Recognition Techniques, Face Databases

**Unit IV:**

History of Fingerprints, Formation of Fingerprints, Individuality of Fingerprints, Fingerprint Sensing and Storage, Fingerprint Representation and Feature Extraction, Fingerprint Matching, Fingerprint Classification and Indexing, Synthetic Fingerprints, Biometric Fusion

**Suggested Readings:**

1. Anil K. Jain, Patrick Flynn, Arun A. Ross, "Handbook of Biometrics" Springer 2008, ISBN 978-0-387-71040-2
2. Arun A. Ross, Karthik Nandakumar and Anil K. Jain, "Handbook of Multibiometrics", Springer, 2006, ISBN 978-0-387-22296-7
3. D. Maltoni, D. Maio, Anil K. Jain and Salil Prabhakar "Handbook of Fingerprint Recognition", Springer, 2009, ISBN 978-1848822535.
4. Stan Z. Li and Anil K. Jain "Handbook of Face Recognition", Springer; 2nd ed., 2011, ISBN 978-0856289314

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T03D: Mobile Phone and Digital Device Forensics**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To understand the architecture of mobile devices (SIM, Data Storage, Operating Systems) and the legal/forensic principles governing their investigation.
2. To learn the standard operating procedures for the seizure, preservation, acquisition, and analysis of mobile evidence.
3. To differentiate between the architecture and forensic challenges of the Android and iOS platforms.
4. To explore complex file systems, memory types, and the impact of mobile malware on forensic integrity.

**Course Outcomes:**

1. Identify the components of SIM architecture and mobile storage to perform data extraction while adhering to standard acquisition procedures.
2. Apply forensically sound techniques to handle, preserve, and examine mobile devices as sources of digital evidence.
3. Analyze and compare the technological compositions of Android and iOS platforms to select appropriate forensic tools for each.
4. Evaluate various mobile file systems (yaffs2, sysfs, etc.) and implement logical vs. physical techniques to detect and mitigate mobile malware.

**Unit I: Mobile Forensics**

Cell phone and mobile device forensics, Understanding Mobile device forensics, Understanding acquisition procedure, Cell phone Crimes, SIM Architecture, Data Storage, Data Extraction, Files Stored on SIM, Mobile Operating System

**Unit II: Digital Evidence**

Types of Evidence on Mobile Devices, Handling Mobile Devices as Sources of Evidence, Forensic Preservation of Mobile Devices, Forensic Examination and Analysis of Mobile Devices, Forensic Acquisition and Examination of SIM Cards

### **Unit III: Android and iOS Systems**

Introduction to Android Platform and iOS Platform, Architecture, Differentiation, Technological Composition

### **Unit IV: Mobile File Systems and Data Structures**

Types of Memory, File Systems, Rootfs, devpts, sysfs, cgroup, yaffs2, Procedure for handling an Android Devices, Logical Techniques Vs Digital Techniques, Introduction to Mobile Malware

### **Suggested Readings:**

1. Guide to Computer Forensics and Investigations By Bill Nelson, Amelia Phillips, Christopher Stuart
2. Digital Evidence on Mobile Devices Digital Evidence and Computer Crime, Third Edition Eoghan Casey. Published by Elsevier Inc. All rights reserved
3. Android Forensic, Investigation, and Security by Andrew Hogg, Publisher Synergy
4. Security in Mobile Communication by Professor Nouredine Boudriga
5. Mobile Malware Attacks and Defense By Ken Dunham

## **M. Sc. Forensic Science Semester - IV**

### **DSC: MFS4T04D: Malware Forensics**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02    30 Lectures/Semester**

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#### **Course Objectives:**

1. To teach the creation of isolated, sandboxed lab architectures (Linux/Windows VMs) to safely handle live malicious binaries.
2. To provide a toolkit and methodology for collecting volatile data (RAM) and non-volatile data from systems currently under attack.
3. To master Static Analysis techniques for identifying malware characteristics (hashes, strings, headers) without executing the code.
4. To develop proficiency in Dynamic Analysis, observing malware in a "run-time" state to capture network traffic, process changes, and system interactions.

#### **Course Outcomes:**

1. Malware analysis lab using virtualization and perform basic memory forensics to recover artifacts from RAM.
2. Execute a Live Incident Response, correlating open ports with malicious processes and preserving digital evidence while maintaining the integrity of the crime scene.
3. De-obfuscate and Fingerprint malware using tools like FLOSS and Exeinfo PE to identify packers, cryptors, and unique cryptographic hashes.
4. Profile malware behavior by monitoring real-time system calls, registry changes, and network traffic using Wireshark and Process Monitor.

#### **Unit I: Malware analysis**

Malware, Malware Analysis, Types of Malware Analysis, Setting Up the Lab Environment: Lab Requirements, Overview of Lab Architecture, Setting Up and Configuring Linux VM, Setting Up and Configuring Windows VM, Malware Sources, Memory Forensic

#### **Unit II: Malware Incident Response**

Building Your Live Response Toolkit, Volatile Data Collection Methodology, Collecting Process Information, Correlate Open Ports with Running Processes and Programs, Identifying Services and Drivers, Determining Scheduled Tasks, Collecting Clipboard Contents, Non-Volatile Data Collection from a Live Windows System, Forensic Duplication of Storage Media on a Live Windows System, Forensic Preservation of Select Data on a Live Windows System, Volatile Data Collection Methodology, Non-Volatile Data Collection from a Live System

### **Unit III: Static Analysis of malwares**

Determining the File Type: Identifying File Type Using Manual Method, Identifying File Type Using Tools, Fingerprinting the Malware: Generating Cryptographic Hash Using Tools, Determining Cryptographic Hash in Python, Multiple Anti-Virus Scanning: Scanning the Suspect Binary with Virus Total, Querying Hash Values Using Virus Total Public API, Extracting Strings: String Extraction Using Tools, Decoding Obfuscated Strings Using FLOSS, Determining File Obfuscation: Packers and Cryptors, Detecting File Obfuscation Using Exeinfo PE

### **Unit IV: Dynamic Analysis of Malwares**

Dynamic Analysis Steps

Dynamic Analysis (Monitoring) Tools: Process Inspection with Process Hacker, Determining System Interaction with Process Monitor, Logging System Activities Using Noriben, Capturing Network Traffic with Wireshark

Dynamic-Link Library (DLL) Analysis: Analyzing the DLL Using rundll32.exe, analyzing a DLL with Process Checks

### **Suggested Readings:**

1. Learning Malware Analysis by Monnappa K A Publisher: Packt Publishing
2. Malware Forensics by James M. Aquilina, Eoghan Casey, Cameron H. Malin Publisher: Syngress

**M. Sc. Forensic Science Semester - IV**

**DSC: MFS4P01D: Practical - I**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02    60 Lectures/Semester**

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**Course Outcomes:**

1. To capture the volatile data from live systems and mobile devices without altering the source evidence.
2. To perform low-level data manipulation and file analysis using hex editors and MAC (Metadata) analysis.
3. To understand the role of cellular infrastructure (Tower sites/Hubs) in tracking and locating mobile devices.
4. To utilize network enumeration and process monitoring tools to identify hidden threats like Trojans and unauthorized wireless intrusions.
5. To explore the methods and tools used for Steganography and SQL Injection to better detect and counter them.

**Practical: (Minimum of 08 has to be completed)**

1. Live system evidence Capture process
2. Advance Mobile device forensic analysis
3. Working with Winhex
4. Working on Cell phone tower site and Cell phone Hub
5. Detail MAC Analysis
6. NetBIOS Enumeration Using NetView Tool, Nbtstat Enumeration Tool (Open Source).
7. How to Detect Trojans by using – Netstat, fPort, TCPView, CurrPorts Tool, Process Viewer.
8. Wireless Network attacks , Bluetooth attacks
9. Understanding SQL Injection
10. Steganography using tools: Tool: Merge Streams, Image Hide, Stealth Files, Blindside, STools, Steghide, Steganos, Pretty Good Envelop, Stegdetect

**M. Sc. Forensic Science Semester - IV**  
**DSE: MFS4T05D: Computer Forensic and Digital Investigation**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To gain a comprehensive understanding of the EnCase environment, including configuration, navigation, and case management.
2. To apply the NIST standards for digital evidence acquisition and verification through hands-on case studies.
3. To learn how to parse complex Windows artifacts, emails, and file structures using built-in evidence processors.
4. To master precise data retrieval using GREP operators, index searches, and hash libraries.
5. To introduce the EnScript programming language for automating repetitive forensic tasks and customizing the investigation workflow.

**Course Outcomes:**

1. Configure and navigate the EnCase environment, maintaining the integrity of Case and Evidence files (.E01).
2. Conduct a full forensic acquisition following NIST protocols, including time-zone synchronization and evidence verification.
3. Analyze Windows artifacts and email data using Case Analyzer, and generate professional forensic reports based on filtered search results.
4. Develop basic EnScript programs using variables and loops to automate data extraction and enhance forensic efficiency.

**Unit I:**

Introduction: Installing EnCase, creating a New Case in EnCase, Customizing the Interface, Navigating EnCase, The EnCase Case File, The EnCase Evidence File, EnCase Configuration (ini) Files, Case Templates

**Unit II:**

EnCase Forensic: Case Study: The NIST CFReDS Hacking Case, Creating a Case Plan, Adding Evidence: Acquisition with EnCase Forensic, EnCase Imager, Creating the NIST Hacking Case, Adding and Verifying the Evidence, Setting the Time Zone in EnCase, The EnCase Evidence Processor, Documenting Evidence: Initial Case Documentation, Files with Internal Structure,

Viewing the Evidence Processor Results, Bookmarking Evidence Items, The Blue Check, The Selected Box, The Set Include (Home Plate), Tagging

**Unit III:**

Evidence Processor Modules, The Case Analyzer, Windows Artifacts, Customizing the Case Analyzer, Parsing Email, Keywords and Searching, Index Searches, Using GREP Operators, Conditions and Filters, Working with Hash Sets and Libraries, Viewing Timeline Data in EnCase, Customizing Existing Report Templates, Creating a New Report Template, Evidence Lifecycle Management, The Digital Evidence Lifecycle, Case Closure Criteria, Inactive Case Review, Archiving a Case

**Unit IV:**

Introduction to EnScript, the EnScript Environment, Variables, Operators, Looping Constructs - Controlling the Flow of an EnScript, Functions, and Classes

**Suggested Readings:**

1. Computer Forensics and Digital Investigation with EnCase Forensic v7 by Suzanne Widup, [McGraw-Hill Education (Publisher)]

**M. Sc. Forensic Science Semester - IV**

**DSE: MFS4P02D: Practical - II**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 02    60 Lectures/Semester**

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**Course Outcomes:**

1. Initialize a forensic investigation by installing EnCase and configuring a new Case File (.case) with proper metadata.
2. Write Blocking Apply FastBlock SE (Software Edition) or hardware equivalents to prevent data modification on original evidence media.
3. Acquisition Create bit-perfect forensic images (.E01 or .Ex01) and verify them using MD5/SHA-1 hashing.
4. Discovery Execute complex Keyword Searches and use Hash Sets to filter out known system files or "de-NIST" the evidence.
5. Advanced Analysis Identify file type discrepancies using File Signature Analysis and Recover files from unallocated space.
6. Reporting Generate a comprehensive, structured Forensic Report that summarizes all bookmarks and findings for legal review.
7. Automation Interpret and utilize basic EnCase Scripts (EnScripts) to automate data parsing and artifact extraction.

**Practical: (Minimum of 08 has to be completed)**

1. Installation of EnCase
2. Creating New Case in EnCase
3. Understanding FastBlock SE and its application
4. Acquiring Evidence in EnCase
5. Demonstration of Keyword Search using EnCase
6. Demonstration of file hash comparison using EnCase
7. Demonstration of Deleted Data Recovery using EnCase
8. Demonstration of File Signature analysis using EnCase
9. Demonstration of Forensic Report Generation using EnCase
10. Understanding EnCase Scripting

# **Specialization – V**

## **Forensic Physics and Ballistics**

**M. Sc. Forensic Science Semester - IV**

**DSC: MFS4T01E: Spectroscopy - II**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To impart fundamental understanding of atomic, magnetic, and nuclear spectroscopic techniques used for qualitative and quantitative elemental and material analysis.
2. To develop the ability to select, operate, and interpret data from advanced analytical instruments such as AAS, AES, NMR, ESR, VSM, and NAA for scientific and industrial applications.

**Course Outcomes:**

1. Explain the principles, instrumentation, and operational aspects of atomic absorption, atomic emission, magnetic resonance, and neutron activation techniques.
2. Analyze and interpret experimental data obtained from AAS, AES, NMR, ESR, VSM, and NAA for elemental, structural, and magnetic characterization.
3. Compare different analytical techniques such as AAS and ICP-AES, NMR and ESR, and justify their suitability for specific analytical problems.
4. Apply spectroscopic and nuclear analytical methods to real-world problems in materials science, chemistry, environmental analysis, and related research fields.

**Unit I:**

**Atomic Absorption Spectroscopy:** Principle of AAS, Instrumentation for AAS, Interference in AAS, Detection Limit and Sensitivity, Background correction methods, graphite furnace quantitative analysis, applications of AAS.

**Unit II:**

**Atomic Emission Spectroscopy:** Principle of AES, Arc emission, Instrumentation for AES, Comparison of ICP-AES and AAS, Applications of AES.

**Unit III:**

**Magnetic Characterization:** Principle and theory of Nuclear Magnetic Resonance and Electron Spin resonance, Instrumentation for NMR and ESR, Applications of NMR and ESR, Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, Applications of VSM.

**Unit IV:**

**Neutron Activation Analysis:** Principle of Nuclear reactions, Neutron Sources, Principle and Theory of Neutron Activation Analysis (NAA), Instrumentation and application of NAA.

**Suggested Readings:**

1. Principles of Instrumental Analysis – Skoog, Holler, Crouch
2. Instrumental Methods of Analysis – Willard, Merritt, Dean, Settle
3. Introduction to Spectroscopy – Pavia, Lampman, Kriz
4. Spectroscopy of Organic Compounds – P.S. Kalsi
5. Fundamentals of Molecular Spectroscopy – C.N. Banwell, E.M. McCash
6. Modern Spectroscopy – J. Michael Hollas
7. Organic Spectroscopy – William Kemp
8. Physical Methods in Chemistry – R.S. Drago
9. Analytical Chemistry: Principles and Techniques – Larry Christian
10. Infrared and Raman Spectroscopy – Norman Colthup, Lawrence Daly, Stephen Wiberley

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T02E: Radiation and Mass Spectrometry**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To provide fundamental knowledge of nuclear radiations, radiation detection systems, and mass spectrometric techniques used in scientific and analytical investigations.
2. To develop the ability to understand the working principles, instrumentation, and applications of modern analytical techniques such as Mass Spectrometry and ICP-MS.

**Course Outcomes:**

1. Explain the production, characteristics, sources, and applications of different types of nuclear radiations.
2. Describe the principles, construction, and working of various nuclear radiation detectors and evaluate their performance characteristics.
3. Interpret the principles of mass spectrometry, ionization techniques, fragmentation patterns, and apply mass spectral data for molecular and elemental analysis.
4. Understand the theory, instrumentation, advantages, and applications of ICP-MS and apply it for trace and ultra-trace elemental analysis in diverse fields.

**Unit I:**

**Nuclear Radiations:** Principle of Production of Nuclear radiation, Types and Characteristics of different nuclear radiations, Sources of Nuclear radiation, Applications of Nuclear Radiations.

**Unit II:**

**Radiation Detectors:** Principle, Characteristics and Types of Nuclear Radiation Detectors – GM counter, proportional counter, scintillation detector, semiconductor detectors.

**Unit III:**

**Mass Spectrometry:** Principle and theory of Mass spectrometry, Ionization methods, Instrumentation for Mass Spectrometer, Fragmentations in Mass spectrometry, high resolution mass spectrometry, applications of Mass Spectrometry.

#### **Unit IV:**

**Inductively Coupled Plasma Mass Spectrometry:** Principle and theory of production of plasma, Principle, theory and Instrumentation of ICP-MS spectrometry, Advantages of ICP-MS, applications of ICP-MS.

#### **Suggested Readings:**

1. Radiation Detection and Measurement – Glenn F. Knoll
2. Measurement and Detection of Radiation – Nicholas Tsoulfanidis, Sheldon Landsberger
3. Modern Physics – Raymond A. Serway, Clement J. Moses, Curt A. Moyer
4. Mass Spectrometry Handbook – J. R. De Laeter et al.
5. Mass Spectrometry: A Textbook – J. H. Gross
6. Instrumental Methods of Analysis – Willard, Merritt, Dean, Settle
7. Principles of Instrumental Analysis – Douglas A. Skoog, F. James Holler, Stanley R. Crouch
8. Practical Aspects of Ion Trap Mass Spectrometry – D. J. Douglas, S. A. McLuckey, G. C. Stafford
9. Inductively Coupled Plasma Mass Spectrometry – A. Montaser
10. Physics and Engineering of Radiation Detection – Syed Naeem Ahmed

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T03E: Physical Evidence - II**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To provide comprehensive knowledge of physical, tool mark, and impression evidence relevant to forensic examination and crime scene investigation.
2. To develop practical understanding of restoration techniques used for recovering obliterated or altered marks on various materials for forensic identification.

**Course Outcomes:**

1. Explain the principles and methods used in the examination of physical evidences such as wires, locks, jewellery, construction materials, fabrics, and labels.
2. Identify, classify, and compare different types of tool marks and impression evidences, and assess their forensic significance.
3. Collect, preserve, and interpret impression evidence including tyre marks, footwear marks, seals, stamps, and mechanical impressions in a scientifically acceptable manner.
4. Apply appropriate restoration techniques to recover erased or obliterated serial numbers and marks on metals and non-metals, and accurately record the restored evidence for forensic analysis.

**Unit I:**

**Other Physical Evidences:** Principle and methods for Examination of cables, cut wires, locks, keys, real and imitation, jewellery, Ropes, tungsten filaments, fuse wire, construction materials, Steel bars, cloth pieces, duplicate labels.

**Unit II:**

**Tool Marks:** Types and characteristics of Tool marks, Combination of marks, repetitive marks, materials for making tool marks, Methods of preparation of tool marks, comparison of test and evidence tool marks.

**Unit III:**

**Impression Evidence:** Rubber Stamp Impressions, Metallic Seal Impressions, Embossed Impressions and Indentation marks, Mechanical Impressions, Cast, Engraved and Punched Marks, Tyre marks, Footwear marks, Collection and preservation of Impression evidence, Significance of impression evidence.

#### **Unit IV:**

**Restoration:** Restoration of erased numbers, methods used for removal of serial numbers, theory behind restoration of obliterated marks, restoration of marks on cast iron, Aluminum, brass, wood, leather etc., methods of restoration – Chemical, Electrolytic, Ultrasonic cavitation, mantic particle method, laser etched serial numbers and bar codes and their restoration, recording of restored marks.

#### **Suggested Readings:**

1. Forensic Science – Richard Saferstein
2. Forensic Science: An Introduction to Scientific and Investigative Techniques – Stuart H. James, Jon J. Nordby
3. Criminalistics: An Introduction to Forensic Science – Richard Saferstein
4. Introduction to Forensic Sciences – William G. Eckert
5. Forensic Science in Criminal Investigation and Trials – B.R. Sharma
6. Principles and Practice of Criminalistics: The Profession of Forensic Science – Keith Inman, Norah Rudin
7. Forensic Examination of Fibres – J. Robertson, M. Grieve
8. Forensic Examination of Glass and Paint: Analysis and Interpretation – Brian Caddy
9. Soil Analysis in Forensic Taphonomy – M. Tibbett, D.O. Carter
10. Advances in Forensic Human Identification – Xanthe Mallett, Teri Blythe, Rachel Berry

**M. Sc. Forensic Science Semester - IV**  
**DSC: MFS4T04E: Forensic Ballistics - II**  
**Max. Marks: 60 (Theory) + 40 (Internal)      Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. To provide in-depth understanding of wound ballistics and the factors influencing firearm injuries produced by handguns, rifles, and shotguns.
2. To develop the ability to evaluate firearm-related injuries and associated forensic evidence for reconstruction of shooting incidents.

**Course Outcomes:**

1. Explain the principles of terminal ballistics and describe the formation and characteristics of entrance wounds, exit wounds, wound tracks, and explosive wounds.
2. Analyze shotgun and rifle wounds by correlating injury patterns with weapon type, ammunition characteristics, range, angle of fire, and target conditions.
3. Differentiate injuries caused at contact, near-contact, intermediate, and distant ranges of fire for various body regions.
4. Evaluate firearm-related evidence such as GSR, pellet and wad distribution, muzzle patterns, and scene marks to determine calibre, range of fire, time since firing, and circumstances of discharge.

**Unit I:**

**Terminal Ballistics:** Wounding Mechanism, Elements of Wound Ballistics – Nature of Target, Velocity, Constructional Features of projectile, Range of Fire, Explosive Wounds– Formation and characteristics, Characteristics of Entrance Wounds, Exit Wounds and Track, Extraneous Deposits at Close Range – Pink Colouration, Charring, Blackening, Tattooing, Dirt Ring, Foreign Material, Contusion.

**Unit II:**

**Shotgun Wounds:** Dependence of wound ballistics on Composition of Shotgun cartridge, Construction Design of the Shotgun, Range and Angle of Fire, Velocity of Projectile, Human Target, Intermediate Target in the bullet trajectory. Factors affecting the injuries, Characteristics of injuries at Contact range, Near Contact range, Powder range and distant range to Head, Torso and limbs.

### **Unit III:**

**Rifle Wounds:** Dependence of wound ballistics on type of rifle viz. Low Velocity rifle, sporting rifle, service & Assault rifle and Handgun, Range and Angle of Fire, Velocity of Projectile, Human Target, Intermediate Target in the bullet trajectory. Factors affecting the injuries, Characteristics of injuries at Contact range, Near Contact range, Powder range and distant range to Head, Torso and limbs.

### **Unit IV:**

**Evaluations:** Determination of calibre, accidental discharge of a firearm, Identification of the shooter on Nature of the Firearm, Barrel Length, Time elapsed since firing, use of propellants and primers, distribution of GSR, Determination of Time of Fire by evaluating GSR, Powder, Dust, Rust, Constituents of Primer like Mercury, Estimation of range of fire on the basis of Muzzle Pattern, Ejecta inside the wound, Scorching, GSR, Blackening, Tattooing, Metallic Residues, Wad distribution, Pellet Pattern, Injuries, Marks on objects at the scene of occurrence .

### **Suggested Readings:**

1. Handbook of Firearms and Ballistics: Examining and Interpreting Forensic Evidence, Brian J. Heard
2. Ballistics: Theory and Design of Guns and Ammunition, Donald E. Carlucci, Sidney S. Jacobson
3. Firearm and Toolmark Examination and Identification (Advanced Forensic Science Series), Max M. Houck (editor)
4. Firearms, the Law, and Forensic Ballistics, Tom Warlow
5. Applied Ballistics for Long Range Shooting, Bryan Litz
6. Modern Exterior Ballistics: The Launch and Flight Dynamics of Symmetric Projectiles, R. McCoy
7. Chemical Analysis of Firearms, Ammunition, and Gunshot Residue, James Smyth Wallace
8. Forensic Ballistics (regional/academic texts), Karan Sharma
9. Forensic Science: An Introduction to Scientific and Investigative Techniques, Stuart H. James, Jon J. Nordby
10. Principles and Practice of Criminalistics: The Profession of Forensic Science, Keith Inman, Norah Rudin

## M. Sc. Forensic Science Semester - IV

### DSC: MFS4P01E: Practical - I

**Max. Marks: 60 (Practical) + 40 (Internal)      Credits: 02    60 Lectures/Semester**

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Perform experiments related to magnetic resonance, magnetization, plasma diagnostics, and radiation detection, and analyze the resulting data using appropriate physical models.
2. Measure and interpret magnetic and plasma parameters using instruments such as ESR spectrometer, GM counter, and vibrating sample magnetometer.
3. Apply scientific methods for the collection, preservation, and analysis of forensic evidence including footwear marks, tyre marks, gunshot residues, and obliterated marks.
4. Correlate experimental observations from physical and forensic experiments to real-world applications in materials science, nuclear physics, and forensic investigations.

#### **Practical: (Minimum of 08 has to be completed)**

1. Study of Electron Spin Resonance
2. Analysis of Hysteresis Loop of Ferromagnetic Material
3. Counting Statistics of Radioactive Particles using GM Counter
4. Measurement of Plasma Parameters
5. Measurement of Magnetic Moment using Vibrating Sample Magnetometer
6. Collection and Analysis of Footwear Marks
7. Collection and Analysis of Tyre Marks
8. Restoration of Erased / Obliterated Marks
9. Chemical Tests for Powder Residues (GSR)
10. Study of Wounds Caused by Firearms

#### **Suggested Readings:**

1. Principles of Instrumental Analysis – Skoog, Holler, Crouch
2. Handbook of Firearms and Ballistics – Brian J. Heard
3. Radiation Detection and Measurement – Glenn F. Knoll
4. Electron Spin Resonance: Analysis and Interpretation – J. E. Wertz, J. R. Bolton
5. Experimental Methods in Magnetism and Magnetic Materials – J. M. D. Coey
6. Forensic Science Handbook, Volume I – R. Saferstein, E. T. Houck

## M. Sc. Forensic Science Semester - IV

**DSE: MFS4T05E: Microscopy, Nephelometry, Turbidimetry and Thermal Methods**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02 30 Lectures/Semester**

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### **Course Objectives:**

1. To provide comprehensive knowledge of optical, advanced, and scanning probe microscopes along with light scattering and thermal analytical techniques used for material and forensic analysis.
2. To develop an understanding of the principles, instrumentation, and applications of microscopy, nephelometry, turbidimetry, and thermal methods for characterization of materials and substances.

### **Course Outcomes:**

1. Explain the principles, working, and applications of optical microscopes including compound, polarized, fluorescence, stereo-zoom, and comparison microscopes.
2. Describe the working principles and applications of advanced microscopes such as TEM, SEM, SEM-EDX, STM, AFM, and video-zoom microscopes.
3. Understand and compare nephelometry and turbidimetry techniques, interpret light scattering data, and apply these methods for qualitative and quantitative analysis.
4. Explain the principles, instrumentation, and applications of thermal analysis techniques including DSC, TGA, and DTA for material characterization and analysis.

### **Unit I:**

**Optical Microscopes:** Principle, working, significance and applications of Compound Microscope, Polarized Microscopes, Fluorescence Microscopes, Stereo-zoom Microscope, Comparison Microscope.

### **Unit II:**

**Advanced Microscopes:** Principle, working, significance and applications of Transmission Electron Microscope, Video-zoomMicroscope, Scanning Electron Microscope, Scanning Electron Microscope-Energy Dispersive X-Ray, Scanning Tunnelling Microscope (STM) and Atomic Force Microscope (AFM).

**Unit III:**

**Nephelometry and Turbidimetry:** Light Scattering, Principle and theory of Nephelometry and turbidimetry, Concentration and Scattering, Instrumentation for Nephelometry and turbidimetry, Comparison between Nephelometry and turbidimetry, applications.

**Unit IV:**

**Thermal Methods:** Principle and theory of Differential Scanning Calorimetry (DSC), Thermo Gravimetric Analysis (TGA) and Differential Thermal Analysis (DTA), Instrumentation and Applications for DSC, TGA and DTA.

**Suggested Readings:**

1. Introduction to Microscopy – David J. McCabe
2. Optical Microscopy – David B. Murphy
3. Electron Microscopy: Principles and Techniques for Biologists – John J. Bozzola, Lonnie D. Russell
4. Scanning Electron Microscopy and X-ray Microanalysis – Joseph Goldstein et al.
5. Scanning Probe Microscopy and Spectroscopy – Roland Wiesendanger
6. Instrumental Methods of Analysis – Willard, Merritt, Dean, Settle
7. Principles of Instrumental Analysis – Douglas A. Skoog, F. James Holler, Stanley R. Crouch
8. Nephelometry and Turbidimetry – K. S. Rangappa, K. M. Murthy
9. Thermal Analysis – Wesley W. Wendlandt
10. Introduction to Thermal Analysis – Michael E. Brown

## M. Sc. Forensic Science Semester - IV

### DSE: MFS4P02E: Practical - II

Max. Marks: 60 (Practical) + 40 (Internal)

Credits: 02    60 Lectures/Semester

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**Course Outcomes:** Upon successful completion of this practical course, learners will be able to:

1. Perform thermal analysis of materials using DSC and TGA and interpret thermal transitions, mass loss patterns, and stability of samples.
2. Determine resolving power and magnification of optical microscopes and apply these parameters for accurate microscopic examination.
3. Operate stereo, polarizing, and comparison microscopes to examine and document different types of samples.
4. Analyze particle size and morphology of nanoparticles using SEM or TEM techniques.
5. Apply nephelometry and turbidimetry techniques for measurement and comparison of suspended particle concentrations.

**Practical: (Minimum of 08 has to be completed)**

1. Thermal Analysis of Given Sample using DSC
2. Thermal Analysis of Given Sample using TGA
3. Determination of Resolving Power of Microscope
4. Determination of Magnification of Microscope
5. Study of Samples using Stereo Microscope
6. Study of Samples using Polarizing Microscope
7. Study of Samples using Comparison Microscope
8. Study of Particle Size of Nano Particles by SEM /TEM Method
9. Study of Nephelometry
10. Study of Turbidimetry

**Suggested Readings:**

1. Thermal Analysis – Wesley W. Wendlandt
2. Introduction to Thermal Analysis – Michael E. Brown
3. Optical Microscopy – David B. Murphy
4. Electron Microscopy and Analysis – Peter J. Goodhew, John Humphreys, Richard Beanland
5. Principles of Instrumental Analysis – Douglas A. Skoog, F. James Holler, Stanley R. Crouch

**M. Sc. Forensic Science Semester - IV**

**DSC: MFS4T06: Special Law - II**

**Max. Marks: 60 (Theory) + 40 (Internal)**

**Credits: 02    30 Lectures/Semester**

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**Course Objectives:**

1. This course is designed to provide in-depth knowledge of the special criminal laws related to forensic science in India.
2. It aimed at equipping students of forensic science with knowledge of legal procedure prescribed under different special criminal laws.

**Course Outcomes:** After Completion of this course, the students should be able to

1. Learn special legislations related to Forensic Physics and Ballistics laws in India.
2. Learn special legislations related to mentally ill persons in India.
3. Understand the necessity of special criminal legislation for forensic science students.

**Unit I:**

The Arms Act 1959 (Preliminary, Definition of arms, Prohibited Arms, firearms, Types of firearms, Acquisition, Possession, Manufacture, Sale, Import, Export^ And Transport of Arms And Ammunition, Provisions Relating To Licenses, Powers And Procedure, Offences and penalties, Miscellaneous)

The Arms Rules 1962

**Unit II:**

The Explosive Substances Act 1908 (Preliminary, Definitions, Licensing Procedure, Power to make rules conferring powers of inspection, search, seizure, detention and removal., Notice and inquiry of accidents, Punishment for certain offences)

The Explosives Act, 1884 and the Explosives Rules, 2008

**Unit III:**

The Motor Vehicles Act, 1988 with its recent amendments, Preliminary, licensing of drivers of motor vehicles, registration of motor vehicles, control of traffic, insurance of motor vehicles against third party risks, offences, penalties and procedure

The Standards of Weights and Measures Act 1976 (Preliminary, Definition, Establishment of standards of weights and measures, Physical representation of standard units, Standards of Weights and Measures, Offences and their trial)

**Unit IV:**

Mental Healthcare Act 2017 (Preliminary, Definitions, Central Mental Health Authority, State Mental Health Authority, Rights of Persons with Mental Illness, Mental Health Establishments, Mental Health Review Boards, Admission, Treatment And Discharge, Responsibilities Of Other Agencies, Offences And Penalties)

The Digital Personal Data Protection Act (DPDP Act), 2023

**Suggested Readings:**

1. The Explosives Act, 1884 and The Explosives Rules, 2008
2. Standards of weights and Measures Act 1976 (Bare Act) Professional Book Publishers, Delhi
3. Sarkar's Criminal Minor Acts by S.K.Sinha Ray, LexisNexis New Delhi
4. The Motor Vehicles Act 1988 Bare Act.
5. The Motor Vehicles (Amendment) Act, 2019 Bare Act
6. The Arms Act 1959 (Bare Act) Professional Book Publishers, Delhi.
7. Explosive Substances Act 1908 (Bare Act) Professional Book Publishers, Delhi.
8. Mental Healthcare Act 2017 (Bare Act) Professional Book Publishers, Delhi.
9. The Digital Personal Data Protection Act (DPDP Act), 2023.

**M. Sc. Forensic Science Semester - IV**

**DSC: MFS4RP: Project**

**Max. Marks: 60 (Practical) + 40 (Internal)**

**Credits: 06**

**180 Lectures/Semester**

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The Research Project is a core practical component of the program, designed to train students in the essential processes of scientific inquiry and research methodology. The project aims to develop the learner's ability to identify a research problem, conduct a comprehensive literature review, formulate a research hypothesis, and design appropriate methodologies to test the hypothesis. Students are expected to collect, analyze, and interpret data using relevant tools and techniques to draw logical and evidence-based conclusions.

The project emphasizes the development of critical thinking, problem-solving, and academic writing skills. It also prepares students to effectively present their research findings through written reports, oral presentations, and, where applicable, research publications.

The course serves as a preparatory step for doctoral-level research and professional scientific contributions.

Evaluation will be based on the quality of the project report, a viva-voce presentation, and adherence to the assessment criteria outlined in the Evaluation Rubrics.