RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

M.Sc. Forensic Science (As per NEP-2020)

Two Year (Four Semester Degree Course)

Semester I - IV
Teaching and Examination Scheme

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

(Two Year) M.Sc. Forensic Science (As per NEP-2020)

Academic Session 2023-24 Onwards

Scheme of Teaching & Examination

M.Sc. Forensic Science Sem-I

SN	Course Category	Name of Course	Course Code	Teaching Scheme (hrs.)			Total Credit	Examination Scheme						
				(Th)	TU	P		Theory				Practical		
								Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
1	DSC	Advanced Forensic Science	MFS1T01	2	-	2	3	3	80	20	40	25	25	25
2	DSC	Forensic Chemistry and Toxicology	MFS1T02	2	-	2	3	3	80	20	40	25	25	25
3	DSC	Forensic Biology and Serology	MFS1T03	2	-	2	3	3	80	20	40	25	25	25
4	DSC	Digital and Cyber Forensics	MFS1T04	2	-	2	3	3	80	20	40	25	25	25
5	DSC	Criminalistics	MFS1T05	2	-	-	2	3	80	20	40	-	-	-
6	DSE	Forensic Physics and Ballistics /	MFS1T06A /	2	-	4	4	3	80	20	40	50	50	50
		Forensic Psychology	MFS1T06B											
7	RM	Research Methodology	MFS1RM	2	-	4	4	3	80	20	40	50	50	50
Total				**14**	**-**	**16**	**22**		**560**	**140**		**200**	**200**	

M.Sc. Forensic Science Sem-II

SN	Course Category	Name of Course	Course Code	Teaching Scheme (hrs.)			Total Credit	Examination Scheme						
				(Th)	TU	P		Theory				Practical		
								Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
1	DSC	Advanced Forensic Science	MFS2T01	2	-	2	3	3	80	20	40	25	25	25
2	DSC	Forensic Chemistry and Toxicology	MFS2T02	2	-	2	3	3	80	20	40	25	25	25
3	DSC	Forensic Biology and Serology	MFS2T03	2	-	2	3	3	80	20	40	25	25	25
4	DSC	Digital and Cyber Forensics	MFS2T04	2	-	2	3	3	80	20	40	25	25	25
5	DSC	Criminalistics	MFS2T05	2	-	-	2	3	80	20	40	-	-	-
6	DSE	Forensic Physics and Ballistics /	MFS2T06A /	2	-	4	4	3	80	20	40	50	50	50
		Forensic Psychology	MFS2T06B											
7	OJT	OJT/FP	MFS2OJT	-	-	8	4	-	-	-	-	50	50	50
Total				**12**	**-**	**20**	**22**		**480**	**120**		**200**	**200**	

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

M.Sc. Forensic Science Sem-III

Course Category	Name of Course	Course Code	Teaching Scheme (hrs.)			Total Credit	Examination Scheme						
			Th	T U	P		Theory				Practical		
							Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
Specialization-I (Questioned Documents and Fingerprints)													
DSC	Questioned Document Analysis-I	MFS3T01A	2	-	-	2	3	80	20	40	-	-	-
DSC	Advanced Fingerprint Development Method-I	MFS3T02A	2	-	-	2	3	80	20	40	-	-	-
DSC	Forensic Linguistics	MFS3T03A	2	-	-	2	3	80	20	40	-	-	-
DSC	Forensic Photography	MFS3T04A	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS3P01A	-	-	8	4	3-6	-	-	-	100	100	100
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-II (Forensic Chemistry and Toxicology)													
DSC	Advanced Instrumentation - I	MFS3T01B	2	-	-	2	3	80	20	40	-	-	-
DSC	Advanced Forensic Chemistry - I	MFS3T02B	2	-	-	2	3	80	20	40	-	-	-
DSC	Advanced Forensic Toxicology – I	MFS3T03B	2	-	-	2	3	80	20	40	-	-	-
DSC	Advanced Chemistry	MFS3T04B	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS3P01B	-	-	8	4	3-6	-	-	-	100	100	100
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-III (Forensic Biology and Serology)													
DSC	Forensic Biology and Entomology	MFS3T01C	2	-	-	2	3	80	20	40	-	-	-
DSC	Forensic Serology	MFS3T02C	2	-	-	2	3	80	20	40	-	-	-
DSC	DNA Fingerprinting-I	MFS3T03C	2	-	-	2	3	80	20	40	-	-	-
DSC	Microbial Forensics	MFS3T04C	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS3P01C	-	-	8	4	3-6	-	-	-	100	100	100
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-IV (Digital and Cyber Forensics)													
DSC	File System	MFS3T01D	2	-	-	2	3	80	20	40	-	-	-
DSC	Digital Image Processing	MFS3T02D	2	-	-	2	3	80	20	40	-	-	-
DSC	Network Forensics	MFS3T03D	2	-	-	2	3	80	20	40	-	-	-
DSC	Applied Cryptography	MFS3T04D	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS3P01D	-	-	8	4	3-6	-	-	-	100	100	100
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-V (Forensic Physics and Ballistics)													
DSC	Spectroscopy-I	MFS3T01E	2	-	-	2	3	80	20	40	-	-	-
DSC	X-Rays	MFS3T02E	2	-	-	2	3	80	20	40	-	-	-
DSC	Physical Evidence-I	MFS3T03E	2	-	-	2	3	80	20	40	-	-	-
DSC	Forensic Ballistics- I	MFS3T04E	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS3P01E	-	-	8	4	3-6	-	-	-	100	100	100
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
DSC	Special Law-I	MFS3T05A	2	-	-	2	3	80	20	40	-	-	-
RP	Research Project (Per Specialization)	MFS3RP	-	-	8	4	-	-	-	-	50	50	50
Total			**12**	**-**	**20**	**22**		**480**	**120**		**200**	**200**	

M.Sc. Forensic Science Sem-IV

Course Category	Name of Course	Course Code	Teaching Scheme (hrs)			Total Credit	Examination Scheme						
			Th	TU	P		Theory				Practical		
							Exam Hrs.	SEE	CIE	Min.	SEE	CIE	Min.
Specialization-I [Questioned Documents and Fingerprints]													
DSC	Questioned Document Analysis-II	MFS4T01A	2	-	-	2	3	80	20	40	-	-	-
DSC	Advanced Fingerprint Development Method-II	MFS4T02A	2	-	-	2	3	80	20	40	-	-	-
DSC	Forgery and Its Forensic Detection	MFS4T03A	2	-	-	2	3	80	20	40	-	-	-
DSC	Automated Fingerprint Identification System	MFS4T04A	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS4P01A	-	-	4	2	3-6	-	-	-	50	50	50
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-II [Forensic Chemistry and Toxicology]													
DSC	Advanced Instrumentation- II	MFS4T01B	2	-	-	2	3	80	20	40	-	-	-
DSC	Advanced Forensic Chemistry- II	MFS4T02B	2	-	-	2	3	80	20	40	-	-	-
DSC	Advanced Forensic Toxicology- II	MFS4T03B	2	-	-	2	3	80	20	40	-	-	-
DSC	Pharmaceutical and Narcotic Drugs	MFS4T04B	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS4P01B	-	-	4	2	3-6	-	-	-	50	50	50
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-III [Forensic Biology and Serology]													
DSC	Forensic Anthropology and Odontology	MFS4T01C	2	-	-	2	3	80	20	40	-	-	-
DSC	Wildlife and Environmental Forensics	MFS4T02C	2	-	-	2	3	80	20	40	-	-	-
DSC	DNA Fingerprinting-II	MFS4T03C	2	-	-	2	3	80	20	40	-	-	-
DSC	Thanatology and Forensic Pathology	MFS4T04C	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS4P01C	-	-	4	2	3-6	-	-	-	50	50	50
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-IV [Digital and Cyber Forensics]													
DSC	Steganography and Watermarking	MFS4T01D	2	-	-	2	3	80	20	40	-	-	-
DSC	Biometrics	MFS4T02D	2	-	-	2	3	80	20	40	-	-	-
DSC	Mobile Phone and Digital Device Forensics	MFS4T03D	2	-	-	2	3	80	20	40	-	-	-
DSC	Malware Forensics	MFS4T04D	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS4P01D	-	-	4	2	3-6	-	-	-	50	50	50
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
Specialization-V [Forensic Physics and Ballistics]													
DSC	Spectroscopy-II	MFS4T01E	2	-	-	2	3	80	20	40	-	-	-
DSC	Radiation and Mass Spectrometry	MFS4T02E	2	-	-	2	3	80	20	40	-	-	-
DSC	Physical Evidence-II	MFS4T03E	2	-	-	2	3	80	20	40	-	-	-
DSC	Forensic Ballistics- II	MFS4T04E	2	-	-	2	3	80	20	40	-	-	-
DSC	Practical	MFS4P01E	-	-	4	2	3-6	-	-	-	50	50	50
DSE	(Refer Elective Basket)		2	-	4	4	3	80	20	40	50	50	50
DSC	Special Law-II	MFS4T05A	2	-	-	2	3	80	20	40	-	-	-
RP	Research Project (Per Specialization)	MFS4RP	-	-	12	6	-	-	-	-	100	100	100
Total			**12**	**-**	**20**	**22**		**480**	**120**		**200**	**200**	

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*).

The students can opt either the elective paper taught in the college in offline mode or any other equivalent online course of at least 4 credits offered by MOOC or any other such platform. The equivalence of such courses will be decided by the college committee comprising of the faculty members of the department and chaired by the Head of that Department.

Research Project:

'Research Project' being a PRACTICAL course shall be assessed as given in the scheme as per the 'Evaluation Rubrics' mentioned in Annexure III, Eligibility, Guidelines and Scheme of Teaching and Examination for Two Year Master of Science (M.Sc.) Program effective from the academic session 2023-24 and appropriate regulations/guidelines/direction as amended from time to time and as available on the website of RTMNU, Nagpur.

The learner will have to carry out a research-based project work in the third and fourth semester based in the specialization. The learner will be allotted the supervisor in the third semester, after which the learner will finalize the topic of the project work (as per specialization) in consultation with the supervisor.

Assessment:

As mentioned in the Eligibility, Guidelines and Scheme of Teaching and Examination for Two Year Master of Science (M.Sc.) Program effective from the academic session 2023-24 and appropriate regulations/guidelines/direction as amended from time to time and as available on the website of RTMNU, Nagpur.

Elective Basket*

	Name of the Course	Course Code
Semester-III		
Specialization I: Questioned Documents and Fingerprints	Physical Security	MFS3T06A1
	Forensic Accounting and Investigation Standards	MFS3T06A2
Specialization II: Forensic Chemistry and Toxicology	Analytical Chemistry-I	MFS3T06B
Specialization III: Forensic Biology and Serology	Techniques in Forensic Biology	MFS3T06C
Specialization IV: Digital and Cyber Forensics	Image Forensics	MFS3T06D
Specialization V: Forensic Physics and Ballistics	Electronics	MFS3T06E
Semester-IV		
Specialization I: Questioned Documents and Fingerprints	Insurance Fraud Investigation	MFS4T06A1
	Corporate Forensic Investigation	MFS4T06A2
Specialization II: Forensic Chemistry and Toxicology	Analytical Chemistry-II	MFS4T06B
Specialization III: Forensic Biology and Serology	Recombinant DNA Technology and Bioinformatics	MFS4T06C
Specialization IV: Digital and Cyber Forensics	Computer Forensic and Digital Investigation	MFS4T06D
Specialization V: Forensic Physics and Ballistics	Microscopy, Nephelometry, Turbidimetry and Thermal Methods	MFS4T06E

***Choose any one as per specialization**

M.Sc. Forensic Science (NEP)

Semester III & Semester IV Syllabus

M.Sc. Forensic Science Sem III-(NEP)

Specialization I: Questioned Documents & Fingerprints

DSC-SP I

MFS3T01A: Questioned Document Analysis-I

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Course Outcome: By the end of this course the learners 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.

DSC-SP II

MFS3T02A: Advanced Fingerprint Development Method-I

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Course Outcome: By the end of this course, the learners would 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, Chemistry of CA dye stains- Ardrox, basic yellow 40, MBD, Rhodamine 6G, MRM 10, RAY, europium chelate, gentian violet, Sudan black. Health and safety precautions

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

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.

DSC-SP I

MFS3T03A: Forensic Linguistics

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Course Outcome: By the end of this course the learners 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.

DSC-SP I

MFS3T04A: Forensic Photography

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Courses Outcome: By the end of this course the learners 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 accessions 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.

DSC- SP I

MFS3P01A: Practical (Questioned Documents and Fingerprints)

Marks: 200 **Practical: 8 Hrs/Week/batch (120 Hrs/Sem)**

(Based on DSC I-IV: SP I)

(Learners must complete at least 80 percent of the practical from the below list)

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.

DSE- SP I

MFS3T06A1: Physical Security

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Courses Outcome: By the end of this course the learners 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.

DSE- SP I (Practical)

Physical Security

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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.

DSE- SP I

MFS3T06A2: Forensic Accounting and Investigation Standards

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Courses Outcome: By the end of this course the learners 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.

DSE- SP I (Practical)

Forensic Accounting and Investigation Standards

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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.

M. Sc. Forensic Science Sem – III- (NEP)

Specialization II: Forensic Chemistry and Toxicology

DSC-SP II

MFS3T01B: Advanced Instrumentation - I

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and recall key principles and instrumentation related to atomic spectroscopy, infrared spectroscopy, and nuclear magnetic resonance (NMR) spectroscopy.
2. Explain the concepts of dipole moment, IR active vibrations, relaxation processes in NMR, and the systematic interpretation of IR and NMR spectra, highlighting their significance.
3. Apply the principles and laws of UV-Visible spectroscopy, IR spectroscopy, and NMR spectroscopy to analyze forensic samples, interpret spectral data, and determine chemical compositions.
4. Analyze spectral data from UV-Visible, IR, and NMR spectroscopy to determine the presence of specific functional groups.
5. Critically evaluate the applications, advantages and limitations of atomic spectroscopy, IR spectroscopy, and NMR spectroscopy in the identification and analysis of evidence in forensic investigations.

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. Applications, advantages, limitations 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, advantages, limitations and Forensic applications.

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 ^{13}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 ^{1}H and ^{13}C NMR, Use of NMR in Forensic analysis. Advantages and limitations.

DSC-SP II

MFS3T02B: Advanced Forensic Chemistry - I

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and describe the basic concepts, terminology, and chemical properties related to arson, explosives, petroleum products, and cement.
2. Explain the processes and techniques involved in the investigation and analysis of fire/arson scenes, explosive sites, petroleum products, and cement.
3. Apply various extraction and analysis techniques to investigate arson scenes and explosion sites, detect adulterants in petroleum products, and analyze the chemical composition of cement, mortar, and concrete.
4. Analyze evidence collected from arson and explosion crime scenes.
5. Critically evaluate the effectiveness of different investigative and analytical methods used in forensic science, and develop comprehensive scientific reports based on the findings.

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 oils.

Unit IV: 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-microscopic examination, Ignition tests, Sieve test, Density Gradient test. Chemical analysis of cement, mortar and concrete.

DSC-SP II

MFS3T03B: Advanced Forensic Toxicology – I

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and recall various methods for the extraction of poisons from biological and non-biological samples, and the nature, symptoms, and medico-legal significance of different organic, metallic, and non-metallic poisons.
2. Explain the principles and procedures involved in solvent extraction, fractional distillation, dry-ashing, wet digestion, and other extraction methods, as well as the pharmacokinetics and toxicokinetic of organic, metallic, and non-metallic poisons.
3. Apply appropriate extraction techniques and analytical methods, including colour tests, chromatographic, and instrumental techniques, to isolate and identify poisons from blood, urine, stomach washes, vomits, and other samples.
4. Analyze and interpret the symptoms, post-mortem findings, fatal doses, and fatal periods associated with various poisons, and evaluate the results of chemical and instrumental analyses to determine the presence and concentration of toxic substances.
5. Critically assess the effectiveness and limitations of different extraction and analytical methods for poisons, and develop comprehensive forensic reports based on the analysis of poisoning cases, providing accurate medico-legal interpretations.

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.

DSC-SP II

MFS3T04B: Advanced Chemistry

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define and classify chemical and biological warfare agents, industrial toxicants, and nanotoxicants.
2. Identify key physical, biochemical, and toxicological properties of these agents and toxicants.
3. Describe the methods of detection, prevention, and safety measures for exposure to these toxic substances.
4. Analyze case studies to evaluate the forensic significance and real-world implications of exposure to chemical and biological warfare agents, industrial toxicants, and nanotoxicants.
5. Critically assess current scenarios involving the use and potential threats of chemical and biological weapons, as well as the implications of industrial and nanotoxicology.

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. Forensic significance and case studies.

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. Forensic Significance and case studies.

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, forensic significance and case studies.

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 and case studies.

DSC-SP II (Practical)

MFS3P01B- Forensic Chemistry and Toxicology

Marks: 200 **Practical: 8 Hrs/Week/Batch (120 Hrs/Sem)**

(Based on DSC I-IV: SP II)

(Learners must complete at least 80 percent of the practical from the below list)

1. Analysis of dye and pigments by using TLC technique.
2. Analysis of alcohol content in sample by derivatization into known organic compounds and its analysis by GC-MS.
3. Analysis of Mercury in biological materials by Fresenium-Babo method.
4. Analysis of animal Poisons using TLC.
5. Analysis of Plant poisons using TLC. (2)
6. Determination of alcohol in blood and urine sample.
7. Analysis of blood, urine, stomach wash in emergency cases of poisoning.
8. Comparison of fibres by chemical analysis, TLC/ HPTLC/ FTIR. (2)
9. Gas chromatography analysis of Ganja and Charas.
10. Analysis of food material in case of food poisoning by chemical, microscopic and instrumental techniques. (2)
11. Analysis of viscera in case of food poisoning by chemical, microscopic and instrumental techniques. (2)
12. Interpretation of given spectral data of various compounds. (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. Chemical analysis of cement samples (Silica percentage, acid insoluble percent etc.)

DSE-SP II

MFS3T06B: Analytical Chemistry - I

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Identify the basic principles, components, and types of instrumentation used in various chromatographic techniques, including column chromatography, paper chromatography, TLC, HPTLC, Gas Chromatography, and HPLC.
2. Explain the theoretical principles, the processes of sample preparation, separation, detection, and analysis for each method.
3. Demonstrate the practical application of chromatographic techniques and spectroscopic methods in forensic analysis.
4. Evaluate the advantages and limitations of each technique for different types of samples.
5. Apply these techniques to identify and quantify various substances, including drugs, pesticides, explosives, and biological samples.

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 and limitations 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). Advantages and Limitations.

Unit IV: Other Methods & Techniques

Flame Photometry: Principle, theory, instrumentation, working and forensic applications. Advantages and Limitations.

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

Turbidometry: Light Scattering, Concentration and Scattering, Instrumentation of turbidometry, general procedure for operation, Turbidimetric titration, Forensic applications. Advantages and Limitations.

DSE- SP V (Practical)

Analytical Chemistry - I

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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 major constituents (such as caffeine and sodium benzoate) in soft drinks using spectrophotometry.

M.Sc. Forensic Science Sem III-(NEP)

Specialization III: Forensic Biology and Serology

DSC- SP -III

MFS3T01C: Forensic Biology and Entomology

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and describe the various types of fibers, plant materials, biological evidence, their sources, and their physical and chemical properties.
2. Apply appropriate forensic techniques to analyze fibers, botanical samples, biological evidence, and entomological specimens.
3. Analyze and interpret forensic evidence from fibers, botanical samples, biological materials, and entomological specimens.
4. Differentiate between various types of entomological evidence, determining the significance of insect life cycles and species in estimating the post-mortem interval (PMI) in forensic investigations.
5. Integrate various techniques to reconstruct the sequence of events in a criminal investigation involving fibers, plant materials, biological evidence, and entomological specimens.

Unit I: Hair and Fiber Examination

Hair examination- Microscopic, species identification. Fiber examination- microscopic, temporary mount. Maceration of fibers, cross-sectioning, physical methods (twist on drying, floatation method, burning test) by using the following examples Cotton, coir, wool, silk, jute, sisal, abaca, rayon silk, wool, asbestos, nylon. Fabrics & cordage- sample handling, analysis, fabric examination, cordage examination.

Unit II: Forensic Botany

Identification of starch grains, powder and stains of spices etc. Paper and Paper Pulp identification, Microscopic and biochemical examination of pulp material. Identification of wood, physical properties, colour, fluorescence, hardness, weight, odour, lustre, texture. Anatomical features of wood, pore/vessel distribution, size and arrangement, pore numbers, pore arrangements, inclusions, coloured deposits, Identification of spores and pollen grains, microscopic examination and Forensic significance.

Unit III: Other Biological Evidence

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

Unit IV: Forensic Entomology

General Classification and life cycle (Diptera), Insects of forensic importance, Collection of entomological evidence during legal investigations. Collection of meteorological data, specimens before body removal, ground-crawling arthropods on and around the 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.

DSC- SP III

MFS3T02C: Forensic Serology

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Recall and describe the formation, composition, and clinical significance of various body fluids.
2. Explain the principles, procedures, and forensic significance of physical, chemical, and confirmatory tests used in the examination of body fluids.
3. Apply appropriate biochemical markers and techniques for identification.
4. Analyze and interpret results from nucleic acid sequencing methods, including Sanger sequencing, dye primer chemistry, pyrosequencing, and capillary electrophoresis, to identify and characterize genetic material in forensic investigations.
5. Critically evaluate the forensic evidence obtained from body fluid examinations and biochemical markers to draw accurate conclusions and support investigations.

Unit I: Body Fluids

Blood, Urine- Formation, composition, Physical and chemical properties, abnormal constituents and clinical significance. Saliva, Vomit - Composition, formation, Physical and chemical properties, abnormal constituents and clinical significance. Semen and Vaginal fluid- Physical and chemical properties, composition, formation abnormal constituents and clinical significance. Faeces, Sweat, - Composition, abnormal constituents, Physical and chemical properties, formation and clinical significance. Amniotic fluid, Aqueous humour- Clinical significance, formation.

Unit II: Examination of Body Fluids

Physical, Chemical and Confirmatory tests of Blood and blood stains–(TMB, Kastle-Meyer Test, Luminol) (Takayama, Teichmann, Spectrophotometric). Examination of Menstrual blood – (Immunochromatographic assay, RNA-based assays) Physical & Microscopic examination, Identification by Fibrin Degradation product. 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 vomit-test for mucus, test for free HCL (Gunzberg's test), endothelial cells; Examination of urine stains- Odour test, urea nitrate crystal test, creatinine test.

Unit III: Biochemical Markers

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. HP (Heptoglobin characterization) HLA System. Paternity disputes using biochemical markers: Calculation of paternity index. Probability for paternity and maternity.

Unit-IV: DNA Sequencing

Nucleic acid sequencing, Dideoxy sequencing by Sangers method. Dye primer chemistry and dye terminator chemistry, Various types of gels used for sequencing methods, Pyrosequencing. Capillary electrophoresis and fragment analysis. Sequencing by synthesis (Illumina), NanoPore sequencing.

DSC- SP -III

MFS3T03C: DNA Fingerprinting-I

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Recall and describe the principles, methods, and techniques involved in DNA and RNA extraction.
2. Explain the processes and components of Polymerase Chain Reaction (PCR), including different types of PCR.
3. Apply appropriate DNA and RNA extraction techniques to collect and preserve samples from various sources.
4. Analyze population genetics data to determine allele and genotype frequencies, heterozygosity, and probabilities of match
5. Implement techniques for non-human DNA testing, including species identification and genetic markers for wildlife DNA profiling

Unit I: DNA Extraction Methods

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: Polymerase Chain Reaction (PCR)

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, Nanotechnology in PCR. Genetic analysis of chromosome X (pentaplex/heptaplex PCR assay), multiplex Y-STR analysis.

Unit –III: Forensic Genetics

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 ratio of paternity / probability of paternity, Analysis of Variance (ANOVA), Assumptions of One-Way ANOVA.

Unit IV: Non-Human DNA Typing

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. Geographic origin identification- Highly Divergent Populations—Limited Gene Exchange, Divergent Populations with Gene Exchange, Populations with High Gene Exchange.

DSC- SP -III
MFS3T04C: Microbial Forensics

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Recall and list the dynamics of disease transmission, the principles of outbreak investigation.
2. Explain the classification, structure, mode of action, and clinical symptoms of various biological toxins.
3. Apply non-DNA methods such as scanning electron microscopy, atomic force microscopy, Raman spectroscopy, and mass spectrometry to analyze biological signatures in forensic contexts.
4. Analyze epidemiologic data to distinguish between natural and deliberate disease outbreaks, utilizing molecular strain typing and global disease reporting systems.
5. Evaluate handling protocols for biological threat samples in the lab, including specimen collection, environmental sampling, storage, and laboratory analysis, while addressing safety issues.

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, Molecular strain typing, Global disease reporting systems. Investigation of suspicious disease outbreaks: natural and deliberate disease, Importance of disease surveillance. Specimen collection, environmental sampling, sample handling, specimen storage, laboratory analysis. Forensic Handling of Biological Threat Samples in the Lab: test plans to implement operational strategies, safety issues.

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, Surface-enhanced Raman spectroscopy, Mass spectrometry. Advantages, limitations and Forensic Significance.

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) and Ribotyping; Forensic Interpretation of DNA Data, Isotopic Testing and Correlation to Contaminant Source.

DSC- SP -III

MFS3P01C: Practical (Forensic Biology and Serology)

Marks: 200 **Practical: 8 Hr/Week (120 Hrs/Sem)**

(Based on DSC I-IV: SP III)

(Learners must complete at least 80 percent of the practical from the below list)

1. Examination of fiber (cotton, silk, wool, jute, rayon, nylon, asbestos etc.)
2. Biochemical examination of wood, pulp, paper.
3. Examination of plant and animal foods.
4. Examination of faecal matter and faecal stains.
5. Estimation of time since death from entomological evidences.
6. Preliminary examination of blood, semen, saliva, vomit etc.
7. Confirmatory tests of blood, semen, vomit etc.
8. Identification of origin of species (precipitin test)
9. Dried blood grouping by absorption-inhibition/ absorption-elution/ mixed agglutination method.
10. ABO blood grouping from other body fluids
11. Examination of Menstrual blood by microscopic, spectroscopic, electrophoretic method
12. Determination of purity and quantity of DNA.
13. Problems on population genetics.
14. Extraction of mitochondrial DNA from forensic samples.
15. Extraction of genomic DNA from microorganisms.
16. Plasmid DNA separation on gel electrophoresis.
17. DNA detection method: Fluorescent and silver staining.
18. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
19. To perform the PCR amplification using extracted DNA (various biological sources).
20. Visit to autopsy center at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Center, Biodiversity and wildlife Center.

DSE- SP -III

MFS3T06C: Techniques in Forensic Biology

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and describe the principles, working mechanisms, and applications of various chromatographic and hyphenated techniques.
2. Explain the underlying principles, working processes, and applications of different spectroscopic techniques and hyphenated techniques.
3. Apply electrophoresis techniques and blotting techniques to analyze biological samples.
4. Evaluate the properties, synthesis methods, and characterization techniques of nanomaterials to assess their applications in forensic science.
5. Utilize advanced analysis techniques in Forensic Biology to solve complex cases.

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). Forensic Applications, Advantages and Limitations.

Unit II: Spectroscopy

Principle, working and applications of: Ultra-violet and visible spectrophotometer, Infrared spectrophotometer, Atomic absorption spectrometer, Raman Spectrophotometer, Fluorescence spectrophotometer. Principle and applications of Hyphenated techniques of -XRD and NMR. Forensic Applications, Advantages and Limitations.

Unit III: Electrophoresis and Centrifugation

Introduction to Electrophoresis; Various factors affecting electrophoresis; 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.

Introduction to Centrifugation: General Principles of Centrifugation (Sedimentation velocity and sedimentation equilibrium); Preparative: Differential centrifugation; Density gradient centrifugation: Rate Zonal, Isopycnic.

Unit IV: Nanotechnology

Definition of Nano, History and Introduction of nanoscience and nanotechnology; Types of Nanomaterials- Nanoclusters, Solid solutions, Thin-film, Nanocomposites; Mechanical-physical-chemical properties; Synthesis of Nanomaterials: Physical methods- Physical vapour deposition, Arc discharge, Ball Milling; Chemical Methods- Reduction, Solvothermal, Photochemical and Electrochemical; Biological Methods- Plant and microorganisms; Characterization of nanomaterials- Particle size analysis; Microscopic and Spectroscopic analysis. Applications of Nanotechnology in Forensic science- Biosensors, Fingerprints and in DNA analysis.

DSE- SP -III

Practical: Techniques in Forensic Biology

Marks: 100 **Practical: 4 Hr/Week (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

1. Agarose Gel electrophoresis of DNA.
2. Agarose Gel electrophoresis of RNA.
3. Extraction and separation of genomic and 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. Isolation of marker enzymes from goat liver using differential centrifugation.
9. Synthesis of metal nano-particles using chemical synthesis.
10. Synthesis of metal nanoparticles using biological synthesis.
11. Spectroscopic characterization of nanoparticles.
12. To perform Southern blotting.
13. To perform Western blotting.
14. Spectrophotometric analysis of dispersible tablets (Paracetamol, Dispirin, etc).
15. Visit to autopsy center at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Center, Biodiversity and wildlife Center

M.Sc. Forensic Science Sem III-(NEP)

Specialization IV: Digital & Cyber Forensics

DSC- SP IV

MFS3T01D: File System

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and describe the fundamental concepts and data structures associated with various file systems.
2. Explain the structure and components of different file systems, highlighting their unique features and functionalities.
3. Critically evaluate the strengths and weaknesses of different file systems.
4. Analyze the boot sectors, directory entries, and file attributes across different file systems to understand their operational mechanisms and data management techniques.
5. Discuss the practical applications and implications of file system analysis in digital forensics

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.

DSC- SP IV

MFS3T02D: Digital Image Processing

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and describe the fundamental steps and components involved in digital image processing.
2. Understand the processes of image sensing and acquisition, image sampling and quantization.
3. Analyze image enhancement techniques in both spatial and frequency domains.
4. Evaluate image restoration methods and noise models.
5. Demonstrate proficiency in image compression techniques, including error-free and lossy methods, and explain the significance of compression standards.

Unit I: Digital Image Processing

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-I

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-II

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

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

DSC-SP IV

MFS3T03D: Network Forensics

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define the fundamentals of network forensics, including its classification and the challenges faced in this field.
2. Explain the different network forensic process models and frameworks.
3. Demonstrate the ability to investigate cloud environments using virtual machine introspection (VMI) and other cloud-specific forensic techniques.
4. Analyze the process of network forensic acquisition, including the TCP/IP protocol suite, packet capture formats, and Netflow record formats.
5. Evaluate network forensic analysis techniques, including misuse and anomaly detection, as well as forensic attribution methods.

Unit I: Network Forensics-I

Fundamentals of networks and 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 Forensics-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. Wireless Network Attacks, Bluetooth Attacks.

Unit III: Botnet Forensics

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

Unit IV: Cloud Forensics

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

DSC-SP IV

MFS3T04D: Applied Cryptography

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define fundamental concepts of number theory, including modular arithmetic, prime numbers, GCD, and the Chinese Remainder Theorem.
2. Explain the principles and workings of block ciphers and public key cryptography algorithms like RSA, ElGamal, Diffie-Hellman Key Exchange, and ECC.
3. Apply knowledge of cryptographic hash functions.
4. Analyze the security and vulnerabilities of cryptographic implementations through side channel analysis techniques such as power and timing analysis.
5. Evaluate the effectiveness and applications of cryptographic protocols, including key establishment protocols and blockchain technology.

Unit I: Number Theory

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

Unit II: Ciphers

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

Public Key Cryptography: RSA, ElGamal, Diffe-Hellman Key exchange, ECC.

Unit III: Hash Functions

Hash Functions: One-way, 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.

DSC-SP IV

MFS3P01D- Practical (Digital and Cyber Forensic)

Marks: 200 **Practical: 8 Hrs/Week/Batch (120 Hrs/Sem)**

(Based on DSC I-IV: SP IV)

(Learners must complete at least 80 percent of the practical from the below list)

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.

DSE-SP IV

MFS3T06D: Image Forensics

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Define the threats to the integrity of digital media content and the principles of digital content protection.
2. Explain the process and components involved in camera source identification.
3. Demonstrate techniques for detecting copy-move forgery in digital images.
4. Analyze various counter-forensic techniques, including their practical considerations, classifications, and specific targeted attacks.
5. Evaluate the effectiveness and limitations of different image forensic and counter-forensic methods.

Unit I: Image Forensics

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

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

Unit III: Image Forgery Detection

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

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**.**

DSE- SP IV (Practical)

Image Forensics

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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.

M.Sc. Forensic Science Sem III-(NEP)

Specialization V: Forensic Physics and Ballistics

DSC- SP V

MFS3T01E: Spectroscopy-I

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and describe the fundamental principles and theories of various spectroscopic techniques, including UV-Visible, Fluorescence, IR, and Raman spectroscopy.
2. Explain the fundamental principles, sources of radiation, and types of detectors used in UV-Visible, Fluorescence, IR, and Raman spectroscopy.
3. Critically evaluate the effectiveness and limitations of each spectroscopic technique
4. Analyze and compare the different applications and methodologies of UV-Visible, Fluorescence, IR, and Raman spectroscopy.
5. Discuss the specific evidence analysis, forensic applications and importance of each spectroscopic technique.

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, Evidence analysis and Forensic Applications. Advantages and limitations.

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, Evidence analysis and Forensic Applications. Advantages and limitations.

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, Evidence analysis and Forensic Applications. Advantages and limitations.

Unit IV: Raman Spectroscopy

Principle and theory of Raman spectroscopy, Instrumentation for Raman Spectrophotometer, Comparison of IR and Raman spectroscopy, applications of Raman Spectroscopy, Evidence analysis and Forensic Applications. Advantages and limitations.

DSC- SP V

MFS3T02E: X-Rays

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Understand the fundamental principles of X-ray production and their properties.
2. Analyze the interaction of X-rays with matter and the principles of X-ray absorption.
3. Evaluate the use of various X-ray diffraction (XRD) and X-ray Fluorescence (XRF) techniques.
4. Critically evaluate the effectiveness and limitations of these techniques.
5. Demonstrate a comprehensive understanding of the forensic applications of these techniques.

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

X-ray Diffraction, wide-angle X-ray scattering (WAXS) and small-angle X-ray scattering (SAXS), 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. Evidence analysis and Forensic Applications of XRD. Advantages and limitations.

Unit IV: XRF

X-ray Fluorescence, Photoelectron spectroscopy and Auger electron spectroscopy, Wavelength Dispersive X-Ray Fluorescence (WD-XRF), Energy Dispersive X-Ray Fluorescence (ED-XRF), Total Reflection X-Ray Fluorescence, Techniques and applications, Evidence analysis and Forensic Applications. Advantages and limitations.

DSC-SP V

MFS3T03E: Physical Evidence- I

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define and describe the different types of fibres, paints, soil, and glass, including their composition, classification, and physical properties.
2. Explain the principles and techniques involved in the physical and instrumental analysis of fibres, paints, soil, and glass, and how these analyses contribute to forensic investigations.
3. Demonstrate the proper collection and preservation methods for fibre, paint, soil, and glass evidence, and apply standard operating procedures for their examination in a forensic context.
4. Analyze case studies to interpret fibre, paint, soil, and glass evidence, identifying key characteristics and correlating them to forensic findings to support investigations.
5. Critically evaluate the forensic significance of fibre, paint, soil, and glass evidence, assessing their probative value and reliability in various forensic scenarios and legal contexts.

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, Forensic Significance, Case studies.

Unit II: Paints

Types of paint and their composition, physical examination of paint, instrumental analysis of pigment and other components of paint, 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.

DSC-SP V

MFS3T04E: Forensic Ballistics- I

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Recall and list the key components of internal and external ballistics.
2. Explain the principles behind the ignition and burning of propellants, the equations of motion governing projectile trajectory, and the influence of external factors on ballistic behavior.
3. Apply knowledge of firearm and ammunition marks and injuries to analyze crime scene evidence, using specialized forensic techniques.
4. Analyze class and individual characteristics of firearms, ammunition, and other firearm-related evidence using microscopy and advanced imaging techniques.
5. Evaluate the effectiveness and reliability of various gunshot residue (GSR) detection methods, in forensic investigations.

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: Ammunition Examination and Analysis

Location of marks and injuries due to firearm and ammunition on the victim and the culprit, Marks on firearm and fired ammunition, Collection of firearms, 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.

DSC-SP V

MFS3P01E- Practical (Forensic Physics and Ballistics)

Marks: 200 **Practical: 8 Hrs/Week/Batch (120 Hrs/Sem)**

(Based on DSC I-IV: SP V)

(Learners must complete at least 80 percent of the practical from the below list)

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

DSE-SP V

MFS3T06E: Electronics

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Recall the fundamental principles and characteristics of electronic components.
2. Explain the operational principles and applications of various electronic devices.
3. Analyze the functioning of digital electronic components such as logic gates (AND, OR, NOT), flip-flops, counters, shift registers, and memories.
4. Evaluate the use of transistors in constructing logic gates and the role of NAND and NOR gates as universal building blocks.
5. Create and design combinational circuits using digital electronic components.

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: Electronics and Forensic Investigations

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. Examination of Short Circuit, Investigation of Fire due to Short Circuit.

DSE- SP V (Practical)

Electronics

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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
16. Examination of Short Circuits

M. Sc. Forensic Science Sem – III- (NEP)

Common for all Specializations

SP-I/ SP-II/ SP-III/ SP-IV/ SP-V

Semester III

DSC-SP I/II/III/IV/V

MFS3T05: Special Law-I

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Identify and recall the various types of cybercrimes, environmental pollution categories, key provisions of the Arms Act 1959, and the Mental Healthcare Act 2017.
2. Explain the international regulatory framework for cybercrimes, intellectual property issues in cyberspace, constitutional provisions for environmental protection in India, and the licensing procedures under the Explosive Substances Act 1908.
3. Apply the provisions of the Environmental Protection Act, 1986, and the Wildlife Protection Act, 1972, to real-world scenarios to understand their practical implications and enforcement mechanisms.
4. Analyze the causes and effects of different types of environmental pollution, and the legal distinctions.
5. Critically evaluate the rights of persons with mental illness as outlined in the Mental Healthcare Act 2017, and assess the effectiveness of judicial decisions related to environmental and wildlife protection laws in India.

Unit I:

Introduction to Cyber Crime, Different Types of Cyber Crimes. International Regulatory Framework- UNCITRAL Model Law, International Conventions on Cyber Crime. Introduction to Intellectual Property Rights and Cyberspace, Copyright issues in Cyberspace, Trademark issues in Cyberspace. Computer software and related issues.

Unit II:

Meaning and Definition of Environment, Environmental Pollution, Types- Natural and Artificial – Air, Water, Noise, Soil, causes and effects. 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. 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.

Unit III:

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 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.

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.

Semester III

SP I/II/III/IV/V

MFS3RP: Research Project

(As per Specialization)

Marks: 100 **8 Hrs/Week/Batch (120 Hrs/Sem)**

'Research Project' being a PRACTICAL course shall be assessed as given in the scheme as per the 'Evaluation Rubrics' mentioned in Annexure III, Eligibility, Guidelines and Scheme of Teaching and Examination for Two Year Master of Science (M.Sc.) Program effective from the academic session 2023-24 and appropriate regulations/guidelines/direction as amended from time to time and as available on the website of RTMNU, Nagpur.

The objective of the research project is to train the learners in identifying the problem of research, perform a comprehensive literature review, develop the hypothesis, design the experiments/surveys to test the hypothesis, collect and analyze the data and draw conclusions from it. In addition, the aim is also to prepare the student to present the data in various forms such as project report, Presentation in conferences and seminar and research/review paper(s). Research project is also aimed to prepare the learner for doctoral research after completion of the programme.

M.Sc. Forensic Science Sem IV-(NEP)

Specialization I: Questioned Documents & Fingerprints

DSC- SP I

MFS4T01A- Questioned Document Analysis-II

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Course Outcome: 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.

DSC- SP I

MFS4T02A: Advanced Fingerprint Development Method-II

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Course Outcome: 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-Napthoflavone, 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.

DSC- SP I

MFS4T03A: Forgery and its Forensic Detection

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

Course Outcome: 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.

DSC – SP I

Paper MFS4T03A: Automated Fingerprint Identification System

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

Course Outcome: 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.

DSC V: SP I

MFS4P01- Practical (Questioned Documents and Fingerprints)

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Based on DSC I-IV: SP I)

(Learners must complete at least 80 percent of the practical from the below list)

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 typescripts/printed matter/ Scanned documents/ fax.
12. Forensic examination of handwriting 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

DSE- SP I

MFS4T06A1: Insurance Fraud Investigation

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

Course Outcome: 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.

DSE- SP I (Practical)

Insurance Fraud Investigation

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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.

DSE- SP I

MFS4T06A2: Corporate Forensic Investigation

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

Courses Outcome: 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.

DSE- SP I (Practical)

Corporate Forensic Investigation

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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.

M. Sc. Forensic Science Sem – IV- (NEP)

Specialization II: Forensic Chemistry and Toxicology

DSC-SP II

MFS4T01B: Advanced Instrumentation - II

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

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)

Diffractometer, 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) and Transmission Electron Microscopy (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.

Unit IV: Thermo-Gravimetric Analysis (TGA) and Electrophoresis

Introduction, theory, instrumentation and Example of TGA curve, Information from TG curve, factors affecting the TG curve, Forensic applications of Differential Scanning Calorimetry, Thermo-Gravimetric Analysis and Differential Thermal Analysis. Principle, theory, instrumentation, applications of Electrophoresis, Ion-exchange and Size Exclusion (Gel Permeation) Chromatography. Forensic applications, advantages and limitations.

DSC-SP II

MFS4T02B: Advanced Forensic Chemistry - II

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify and recall the chemical properties and forensic significance of various types of beverages, dyes, pigments, fertilizers, and harmful chemicals, as well as the methods used for their detection and analysis.
2. Describe the principles behind the analytical techniques used for detecting and analyzing beverages, dyes, pigments, fertilizers, and harmful chemicals.
3. Apply methods to detect and analyze different types of dyes, pigments, fertilizers, and harmful chemicals in various forensic contexts.
4. Analyze the results of forensic tests to determine the presence and concentration of harmful substances in beverages, dyes, pigments, fertilizers, and other chemicals.
5. Assess the reliability and validity of different analytical techniques used in forensic science for the detection and analysis of prohibited substances, dyes, pigments, fertilizers, and harmful chemicals.

Unit I: Analysis of Beverages and 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 and Pigments

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

DSC-SP II

MFS4T03B: Advanced Forensic Toxicology – II

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Identify the types and sources of food, plant, animal, and miscellaneous poisons. Recall signs, symptoms, and post-mortem findings associated with each type of poison.
2. Explain the mechanisms of action, toxicology, and medico-legal significance of various poisons. Describe the processes for collecting, preserving, and analyzing evidence materials related to food, plant, animal, and miscellaneous poisons.
3. Apply proper methods for the extraction and isolation of poisons from evidence materials.
4. Analyze the clinical signs, symptoms, and post-mortem findings to determine the type of poisoning.
5. Critically assess the medico-legal implications of poisoning cases and the reliability of the tests conducted.

Unit I: Food Poisons

Introduction, types of food poisoning, signs and symptoms of food poisoning, collection and preservation of evidence material, extraction and isolation from food material, biological material, Analysis by colour test and instrumental techniques.

Unit II: Plant Poisons

Introduction, classification, nature, fatal dose, fatal period, signs and symptoms, postmortem findings, medico-legal significance and detection of plant poisons: Dhatura, Abrus precatorious, Nerium oleander, Calotropis gigantia, Gloriosa superba, Ergot, Mushroom etc. Analysis by colour tests, chromatographic and instrumental techniques.

Unit III: Animal Poisons

Introduction, classification, nature, fatal dose, fatal period, signs and symptoms, postmortem findings, medico-legal significance and detection of animal poisons: Cantharides, Spiders, Snakes, Scorpion, etc. Analysis by colour tests, chromatographic and instrumental techniques.

Unit IV: Miscellaneous Poisons

Nature, fatal dose, fatal period, signs and symptoms, post-mortem findings, medico-legal significance and detection (preliminary and confirmatory tests): Asphyxiants, carbon monoxide, carbon dioxide, hydrogen sulphide, nitrous oxides, war gases, etc.

DSC-SP II

MFS4T04B: Pharmaceutical and Narcotic Drugs

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Recall the fundamental concepts of pharmacokinetics and pharmacodynamics, including drug absorption, distribution, metabolism, and elimination processes.
2. Identify the various classes and characteristics of narcotic drugs and psychotropic substances.
3. Explain the mechanisms of drug-receptor interactions, signal transduction, and dose-effect relationships.
4. Use appropriate analytical techniques such as TLC, HPLC, GC, IR, UV-Visible, and mass spectrometry for the analysis of narcotic drugs and psychotropic substances.
5. Examine the medico-legal significance of different narcotic drugs and psychotropic substances through case studies and forensic investigations.
6. Critically evaluate the effectiveness and limitations of different drug analysis methods in forensic science.

Unit I: Pharmacokinetics:

Active and passive absorption, blood-brain barrier and placental filter. Routes of administration, Drug absorption, distribution, metabolism and elimination; Drug bioavailability, bioequivalence and half-life: Pharmacokinetic parameters evaluation; Time course of drug plasma concentrations after single and repeated administrations by multiple dosage regimens.

Unit II: Pharmacodynamics:

Receptor classification. Drug-receptor interactions and signal transduction mechanisms. Dose-effect relationships; agonists, partial agonists and antagonists; Factors that modify drug actions; side effects, overdose, idiosyncratic and allergic reactions; teratogenesis and foetal toxicity: Drug interactions and pharmacogenetics.

Unit III: Narcotics Drugs

Narcotics Drugs and Psychotropic Substances: Introduction, Classification, Nature, Fatal dose, fatal period, signs and symptoms, post-mortem findings, extraction from viscera, blood, vomit, urine etc. Medico-legal significance of opium, stimulants, depressants, hallucinogens, barbiturates, cannabis, sedatives.

Unit IV: Analysis of Narcotics Drugs and Psychotropic Substances

Field tests, colour tests, microcrystal tests, TLC, HPLC, GC, IR, UV-Visible, mass spectrometric analysis of depressants, stimulants, hallucinogens, barbiturates, cannabis, sedatives.

DSC-SP II

MFS4P01B- Practical (Forensic Chemistry and Toxicology)

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Based on DSC I-IV: SP II)

(Learners must complete at least 80 percent of the practical from the below list)

1. TLC, GC analysis of anabolic steroids.
2. TLC, UV-Visible, HPLC Analysis of phenolphthalein in trap cases.
3. Analysis of alcohol content in 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 separation of metal ions by paper chromatography. (2)
7. TLC, GC analysis of barbiturates, benzodiazepine 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.

DSE-SP II

MFS4T06B: Analytical Chemistry - II

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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, idea about food processing and food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder, pulses, milk, oil etc. Analysis of preservatives and coloring material.

DSE- SP II

Practical: Analytical Chemistry - II

Marks: 100 **Practical: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

1. Measurement of soil pH using a potentiometer.
2. Estimation of Calcium and Magnesium Ions as Calcium Carbonate by Complexometric Titration
3. Determination of Ca^{2+} and Mg^{2+} ions concentrations in soil as $CaCO_3$ by complexometric titration method.
4. Determination of water pH (i) using pH paper (calorimetrically) 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 (Cl^-) in deodorants by gravimetric method.
12. Determination of sulfate (SO_4^{2-}) in deodorants by gravimetric method.
13. Determination of boric acid (H_3BO_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.

M.Sc. Forensic Science Sem IV(NEP)

Specialization III: Forensic Biology and Serology

DSC- SP -III

MFS4T01C: Forensic Anthropology and Odontology

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Identify and describe the key concepts, scope, and subfields of anthropology.
2. Explain the processes involved in fossil formation, taphonomy, relative and chronometric dating techniques, and the role of physical anthropology in forensic contexts and mass disasters.
3. Apply field recovery methods, laboratory processing techniques, and curation practices in bio-archeology, ensuring proper chain of custody and accurate identification of skeletal remains.
4. Analyze skeletal remains to determine age at death, sex, ancestry, height, weight, and signs of premortem, perimortem, and postmortem trauma, using anthropological and forensic techniques.
5. Evaluate methods for personal identification of living and deceased individuals through somatometric and somatoscopic observations, skeletal age determination, and forensic odontology.

Unit I: Forensic Anthropology-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: Forensic Anthropology-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

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: Forensic Odontology

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, presentation of bite mark evidences in court of law. Role of Forensic Odontology in mass disaster victim identification.

DSC- SP III

MFS4T02C: Wildlife and Environmental Forensics

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Identify and list protected and endangered species of animals and plants.
2. Describe different methods of killing and poaching wildlife animals.
3. Apply forensic techniques to recover evidence at poaching scenes, locate animal burial sites, and identify reptile species based on scale morphology.
4. Evaluate the sources and detection methods for environmental contaminants.
5. Develop strategies for environmental management and sustainable development.

Unit I: Wildlife Forensics-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 Forensics-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. Basics of reptile scale morphology, Identifying features of major reptile groups. Challenges to species identification of reptile skin products.

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. Sewage-Sources and detection; Lead- sources, compounds, analytical methods and lead forensics. 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.

DSC- SP -III

MFS4T03C: DNA Fingerprinting-II

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Identify and list various advanced techniques in human DNA profiling.
2. Apply DNA fingerprinting techniques to degraded samples and utilize advanced methods.
3. Analyze the status and development of DNA profiling in India and abroad, examining current perspectives, future challenges, and the uses of population databases.
4. Evaluate forensic DNA evidence by interpreting DNA typing results, assessing the strength of evidence through genetic concordance, and performing frequency estimate calculations.
5. Understand the legislation, sample collection, and data transformation processes, while ensuring quality assurance through certification and accreditation.

Unit I: Human DNA Profiling

Advanced techniques in Human DNA profiling: Uni-parentally inherited genetic markers in ethnic and geographical origin detection. DNA Profiling Kits (Easy DNA, Pro-filer Plus 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: Advancements and Challenges in DNA Profiling

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, Uses of STR Typing. New & future technologies: Microarrays technology, Synthetic DNA. Analysis of Degraded DNA, Low Copy Number DNA. Principle and Application of MALDI-ToF Mass Spectrometry in DNA fingerprinting.

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), The DNA Technology (Use and Application) Regulation Bill- 2019.

Unit IV: DNA Databank and Quality Assurance

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.

DSC- SP -III

MFS4T04C: Thanatology and Forensic Pathology

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Identify and describe the various causes, manners, characteristics, and signs of death.
2. Explain the medico-legal aspects of different types of deaths.
3. Apply the knowledge gained to identify and examine decomposed, mutilated bodies, and fragmentary remains, and determine personal identity using forensic methods.
4. Evaluate the procedures and objectives of medico-legal autopsies, including the preservation of articles, body fluids, and viscera in cases of suspected poisoning, and distinguish between antemortem and post-mortem injuries.
5. Assess the types, diagnosis, mode of action, and medico-legal aspects of various poisons.

Unit I: Introduction to Forensic Pathology & Thanatology

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

Unit II: Sexual Offences

Sexual Offences- Sexual assault, Rape, Incest, Adultery; Unnatural Sexual Offences-buccal coitus, sodomy, tribadism, bestiality, etc.). Abortion- Natural and Induced. Infanticide and Child Abuse, Medico-legal aspects of female feticide, legitimacy. Impotence and Sterility, medico-legal aspect of sterilization. Artificial insemination, test-tube baby, surrogate motherhood, Virginity.

Unit-III: Injuries

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. Defence injuries, hesitation cuts; fabricated injuries; simple and grievous hurt, suicidal/accidental/homicidal injuries; Identification of injuries by torture. Regional injuries: Injuries to Head, Neck, Thorax, Abdomen, Pelvis, Genitalia, Vertebral column and Bones.

Unit-IV: Poisons

Types of poisons, diagnosis, Mode of action, and medico-legal aspects of: Animal poisons: Snake and scorpion bites. Deliriants: Dhatura, Cannabis and Cocaine. Somniferous agents: Opium Morphine and other opioids. Asphyxiant poisons: Carbon monoxide, Carbon dioxide, Methane and cyanides. Cardiac poisons: a) *Cerbera thevetia* and *Nerium odorum*, *Cerbera odollam.* Food poisoning by bacteria -example/case study.

DSC- SP III

MFS4P01C: Practical (Forensic Biology and Serology)

Marks: 100 **Practical: 4 Hr/Week (60 Hrs/Sem)**

(Based on DSC I-IV: SP III)

(Learners must complete at least 80 percent of the practical from the below list)

1. To perform extraction and purification of Dhatura/Nerium metabolites.
2. To perform extraction and detection of somniferous agents.
3. To perform spiking of animal tissue with various toxins.
4. To perform extraction and detection of spiked toxins from animal tissue.
5. To perform bite mark analysis on collected samples.
6. To perform dental charting from bitemark.
7. To perform stature estimation from long bones and fragmentary bones.
8. To perform age estimation from various bones.
9. To perform racial analysis from various bones.
10. To calculate time since death from cadaver.
11. To perform extraction of DNA from degraded samples.
12. To perform Interpretation of STR profile.
13. To perform the PCR amplification using degraded DNA samples (various biological sources).
14. To perform BOD/COD analysis from water samples.
15. To perform the heavy metal contaminants from polluted samples.
16. To perform morphological examination of reptile/fish skin.
17. To perform Wildlife crime scene management and evidence collection.
18. Visit to autopsy center at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Center, Biodiversity and wildlife Center.

DSE- SP -III

Practical – MFS4T06C: Recombinant DNA Technology and Bioinformatics

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. List and describe the various molecular tools involved in recombinant DNA technology.
2. Explain the principles and applications of gene cloning vectors.
3. Demonstrate methods for detecting recombinant DNA, including Lac-Z, antibiotic sensitivity assays, and reporter gene assays in practical scenarios.
4. Analyze and compare various biological databases.
5. Evaluate sequence alignment methods and tools, and their effectiveness in different biological research contexts.

Unit-I: Recombinant DNA Technology

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; Vectors derived from Agrobacterium T1 plasmid; Animal viral vectors - SV-40, Cosmids, Artificial chromosomes: YACs and BAC vector; Methods of detection of recombinants- Lac-Z; Antibiotic sensitivity; Reporter gene assay.

Unit-II: Biological Databases and Molecular Visualization

General Introduction and Types of Biological Database. Nucleic acid databases: NCBI, DDBJ, and EMBL. Protein databases: Primary, Composite, and Secondary. Specialized Genome databases: SGD, TIGR, and ACeDB. Structure databases: CATH, SCOP, and PDBsum. Molecular visualization – use of Rasmol, PDB, ExPASY and KEGG.

Unit-III: Sequence Alignments and Phylogenetic Analysis

Sequence Alignments and Visualization, Introduction to Sequences alignments, Local alignment and Global alignment- algorithm and example, Pairwise alignment- BLAST and FASTA Algorithm; Multiple sequence alignment-Clustal W algorithm. Introduction to phylogenetic trees. Methods for presenting large quantities of biological data: sequence viewers- Artemis, SeqVISTA.

Unit-IV: Protein Structure Prediction and Analysis

Protein Tertiary structure prediction methods: Homology Modeling. Fold Recognition, Ab-initio Method, Protein folding. Molecular Dynamics of Protein, Molecular Docking of Protein. Motif and Domain: Motif databases and analysis tools, Domain databases- CDD, SMART, ProDom and Analysis tools.

DSE- SP -III

Practical – MFS4P06C: Recombinant DNA Technology and Bioinformatics

Marks: 100 **Practical: 4 Hr/Week (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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 cloning study of DNA vectors using bioinformatics tools.
12. To perform the DNA primer study using bioinformatics tools.
13. To perform isolation of plasmid from bacteria.
14. To perform secondary structure prediction of protein using bioinformatics tools.
15. To perform 3-dimensional structure prediction of protein using bioinformatics tools.
16. To perform the protein-ligand interactions using bioinformatics tools.
17. To study the protein domain databases.
18. To study the STR databases in forensic biology.
19. Preparation of vector-based recombinant using kit method.
20. Lac-Z reporter enzyme assay for recombinant identification using the kit method.

M.Sc. Forensic Science Sem IV-(NEP)

Specialization IV: Digital & Cyber Forensics

DSC- SP IV

MFS4T01D: Steganography and Watermarking

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Define the concepts of information hiding, steganography, and watermarking, and articulate their importance and applications.
2. Explain the various models of watermarking and the process of watermark detection as well as the principles of basic message coding and error correction coding.
3. Demonstrate techniques for watermarking with side information, including informed embedding and the use of dirty-paper codes.
4. Analyze the security requirements of watermarking systems, the relationship between watermark security and cryptography.
5. Evaluate methods for content authentication, including exact and selective authentication, as well as techniques for localization and restoration in the context of digital watermarking and steganography.

Unit I: Steganography

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: Watermarking-I

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-II

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 and Content Authentication

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

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

DSC- SP IV

MFS4T02D: Biometrics

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Define the concept of biometrics, including its operation within a biometric system, applications across various fields.
2. Understand the limitations and standards associated with biometric systems, and explore the concept of multibiometric systems.
3. Explain spoof detection systems, their historical evolution, and analyze specific case studies such as fingerprint spoofing.
4. Demonstrate knowledge of face recognition technologies, including the processing and analysis of facial subspaces.
5. Analyze the historical development and formation of fingerprints, and evaluate their individuality and reliability as biometric identifiers.

Unit I: Biometrics-I

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

Unit II: Biometrics-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. Applications and challenges.

Unit III: Face Recognition Techniques

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

Unit IV: Fingerprint Biometrics

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.

DSC III- SP IV

MFS4T03D: Mobile Phone and Digital Device Forensics

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Define cell phone and mobile device forensics and gain insights into cell phone crimes, SIM architecture, data storage mechanisms, and mobile operating systems.
2. Explain the types of digital evidence found on mobile devices, proper handling and preservation techniques for mobile devices.
3. Demonstrate understanding of the Android and iOS platforms, including their architectures, technological compositions, and differentiation in terms of forensic analysis.
4. Analyze mobile file systems and data structures and compare logical techniques versus digital techniques used in mobile forensic investigations.
5. Evaluate the significance and challenges of mobile forensics in modern digital investigations, considering legal and ethical implications.

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.

DSC- SP IV

MFS4T04D: Malware Forensics

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define malware and malware analysis, understanding the types and methodologies involved in analyzing malicious software.
2. Explain the techniques and tools necessary for malware incident response.
3. Demonstrate proficiency in static analysis of malware.
4. Analyze the steps involved in dynamic malware analysis.
5. Evaluate the effectiveness of different malware analysis techniques and tools in identifying and mitigating threats.

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 VirusTotal, Querying Hash Values Using VirusTotal 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.

DSC-SP IV

MFS4P01D- Practical (Digital and Cyber Forensic)

Marks: 100 **Lectures: 4 Hrs/Week/Batch (60 Hrs/Sem)**

(Based on DSC I-IV: SP IV)

(Learners must complete at least 80 percent of the practical from the below list)

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

DSE-SP IV

MFS4T06D: Computer Forensic and Digital Investigation

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define the fundamentals of Computer Forensics.
2. Explain the application of EnCase Forensic in real-world scenarios through case studies.
3. Demonstrate proficiency in utilizing Evidence Processor modules, Case Analyzer, and parsing various Windows artifacts and email data.
4. Analyze the process and methodologies involved in the digital evidence lifecycle management, including case closure criteria, inactive case review, and archiving procedures.
5. Assess the effectiveness of digital investigation tools in handling complex forensic investigations and their compliance with forensic standards and legal requirements.

Unit I: Introduction to Encase

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-I

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: EnCase Forensic-II

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

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

DSE- SP IV (Practical)

Practical: Computer Forensic and Digital Investigation

Marks: 100 **Lectures: 4 Hr/Week (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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.

M.Sc. Forensic Science Sem IV-(NEP)

Specialization V: Forensic Physics and Ballistics

DSC- SP V

MFS4T01E: Spectroscopy-II

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Recall the principles of Atomic Absorption Spectroscopy (AAS), Atomic Emission Spectroscopy (AES), Magnetic Characterization (NMR, ESR, VSM), and Neutron Activation Analysis (NAA).
2. Explain the instrumentation setups for AAS, AES, NMR, ESR, VSM, and NAA, including the principles of operation and the specific components involved in each technique.
3. Apply knowledge of these techniques for various analysis.
4. Analyze the advantages and limitations of each analytical technique (AAS, AES, NMR, ESR, VSM, NAA) in the context of forensic applications, considering factors such as sensitivity, selectivity, and sample preparation requirements.
5. Differentiate between the advantages and limitations of these techniques for various analyses.

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. Evidence analysis and Forensic Applications. Advantages and limitations.

Unit II: Atomic Emission Spectroscopy

Principle of AES, Arc emission, Instrumentation for AES, Comparison of ICP-AES and AAS, Applications of AES. Evidence analysis and Forensic Applications. Advantages and limitations.

Unit III: Magnetic Characterization

Principle and theory of Nuclear Magnetic Resonance (NMR) and Electron Spin Resonance (ESR), Instrumentation for NMR and ESR, Applications of NMR and ESR. Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, Applications of VSM. Evidence analysis and Forensic Applications. Advantages and limitations.

Unit IV: Neutron Activation Analysis

Principle of Nuclear reactions, Neutron Sources, Principle and Theory of Neutron Activation Analysis (NAA), Instrumentation and application of NAA. Evidence analysis and Forensic Applications. Advantages and limitations.

DSC- SP V

MFS4T02E: Radiation and Mass Spectrometry

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Recall the principles of nuclear radiation production, types of nuclear radiations, and the sources of nuclear radiation.
2. Explain the principles, characteristics, and types of nuclear radiation detectors including their operational mechanisms.
3. Apply knowledge of mass spectrometry to analyze forensic evidence and interpret mass spectra effectively.
4. Analyze the advantages and limitations of mass spectrometry and inductively coupled plasma mass spectrometry (ICP-MS), considering factors such as sensitivity, resolution, elemental analysis capabilities, and sample throughput.
5. Develop strategies for the forensic application of nuclear radiations, radiation detectors, mass spectrometry, and ICP-MS, including experimental design, method development, data interpretation, and the integration of results into forensic reports.

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. Evidence analysis and Forensic Applications. Advantages and limitations.

Unit II: Radiation Detectors

Principle, Characteristics and Types of Nuclear Radiation Detectors – GM counter, proportional counter, scintillation detector, semiconductor detectors. Forensic Applications. Advantages and limitations.

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. Evidence analysis and Forensic Applications. Advantages and limitations.

Unit IV: Inductively Coupled Plasma Mass Spectrometry

Principle and theory of production of plasma, Principle, theory and Instrumentation of ICP-MS spectrometry, applications of ICP-MS. Evidence analysis and Forensic Applications. Advantages and limitations.

DSC III- SP V

MFS4T03E: Physical Evidence-II

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Recall the principles and methods for examining various physical evidence.
2. Explain the types, characteristics, and significance of tool marks, impression evidence, and restoration techniques in forensic investigations.
3. Apply methods for the examination, collection, and preservation of various impression evidence.
4. Analyze different restoration methods used for erased numbers, obliterated marks, and serial numbers on various materials.
5. Compare and analyze tool marks, including the preparation of test and evidence tool marks, and evaluate the suitability of different restoration methods for specific types of physical evidence in forensic casework.

Unit I: Other Physical Evidences

Principle and methods for Forensic 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, Forensic examination and 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, preservation and Forensic examination, 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, magnetic particle method, laser etched serial numbers and bar codes and their restoration, recording of restored marks.

DSC- SP V

MFS4T04E: Forensic Ballistics - II

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define the key elements and mechanisms of terminal ballistics.
2. Explain the factors influencing wound ballistics in shotgun and rifle injuries.
3. Apply the principles of wound ballistics to evaluate injuries caused by different types of firearms, taking into account the nature of the target, intermediate targets, and specific features of entrance and exit wounds.
4. Analyze firearm evidence to determine the caliber, identify the shooter, and estimate the range of fire by evaluating the ballistic evidence present at the crime scene.
5. Critically assess the methods used for evaluating firearm evidence, to accurately determine the circumstances surrounding the discharge of a firearm and the resulting injuries.

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: Evaluation of Firearm Evidence

Determination of caliber, 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 .

DSC-SP V (Practical)

MFS4P01E- Forensic Physics and Ballistics

Marks: 100 **Practical: 4 Hr/Week (60 Hrs/Sem)**

(Based on DSC I-IV: SP V)

(Learners must complete at least 80 percent of the practical from the below list)

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 Forensic Analysis of Foot/Footwear Marks/Impressions
7. Collection and Forensic Analysis of Tyre Marks/Impressions
8. Restoration of Erased / Obliterated Marks / Erased Serial Numbers
9. Forensic examination of bullet/cartridge/cartridge case
10. Forensic examination and comparison of test and evidence tool marks.
11. Chemical Tests for Powder Residues (GSR)
12. Study of Wounds Caused by Firearms

DSE-SP V

MFS4T06E: Microscopy, Nephelometry, Turbidimetry and Thermal Methods

Marks: 100 **Lectures: 2 Hrs/Week (30 Hrs/Sem)**

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

1. Define the principles and working mechanisms of various optical microscopes, advanced microscopes, nephelometry, turbidimetry, and thermal analysis techniques.
2. Explain the significance and applications of compound microscopes, polarized microscopes, fluorescence microscopes, stereo-zoom microscopes, comparison microscopes, and advanced microscopes.
3. Apply the principles of nephelometry and turbidimetry to measure the concentration and scattering of light in various samples, utilizing appropriate instrumentation techniques.
4. Analyze the data obtained from thermal methods to understand material properties and thermal behavior.
5. Critically evaluate the advantages and limitations of different microscopic, and thermal methods to determine their suitability for specific forensic and scientific applications.

Unit I: Optical Microscopes

Principle, working, significance and applications of Compound Microscope, Polarized Microscopes, Fluorescence Microscopes, Stereo-zoom Microscope, Comparison Microscope. Forensic Applications, Advantages and limitations.

Unit II: Advanced Microscopes

Principle, working, significance and applications of Transmission Electron Microscope, Video-zoom Microscope, Scanning Electron Microscope, Scanning Electron Microscope-Energy Dispersive X-Ray, Scanning Tunnelling Microscope (STM) and Atomic Force Microscope (AFM). Forensic Applications, Advantages and limitations.

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, Forensic applications, advantages and limitations.

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. Forensic applications, Advantages and limitations.

DSE- SP V (Practical)

Practical: Microscopy, Nephelometry, Turbidimetry and Thermal Methods

Marks: 100 **Lectures: 4 Hr/Week (60 Hrs/Sem)**

(Learners must complete at least 80 percent of the practical from the below list)

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

M. Sc. Forensic Science Sem – IV- (NEP)

Common for all Specializations

SP-I/ SP-II/ SP-III/ SP-IV/ SP-V

DSC-SP I/II/III/IV/V

MFS4T05: Special Law-II

Marks: 100 **Lectures: 2 Hr/Week (30 Hrs/Sem)**

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

1. Identify and recall the key provisions, definitions, and authorities as outlined in the Information Technology Act 2000, the Food Safety and Standards Act 2006, the Drugs and Cosmetics Act 1940, the Narcotic Drugs and Psychotropic Substances Act 1985, the Prevention of Illicit Trafficking in NDPS Act 1988, the Standards of Weights and Measures Act 1976, and the Motor Vehicles (Amendment) Act 2019.
2. Explain the principles, processes, and regulations related to electronic records, digital signatures, food safety, drug control, narcotic regulation, and standards of weights and measures.
3. Apply the enforcement provisions, penalties, and adjudication processes from the relevant acts to hypothetical scenarios to understand their practical implications and regulatory requirements.
4. Analyze the roles and responsibilities of various authorities and officers under the different acts, such as the Food Safety and Standards Authority of India, the Cyber Regulations Appellate Tribunal, and the Narcotics Control Bureau, and their impact on regulation and enforcement.
5. Critically evaluate the effectiveness of recent amendments in the Information Technology Act and the Motor Vehicles Act, and assess their impact on improving governance, public safety, and regulatory compliance.

Unit I

The Information Technology Act 2000 with recent Amendments. Preliminary, Definitions, Attribution, Acknowledgment and Dispatch of Electronic Records, Secure Electronic Records and Secure Digital Signatures. Electronic Governance. Regulation of Certifying Authorities, Digital Signature Certificates. Penalties and Adjudication, Offences. The Cyber Regulations Appellate Tribunal, Intermediaries and Network service providers

Unit II

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. The Drugs and Cosmetics Act, 1940 - Preliminary, Definitions, Authorities, Import of Drugs and Cosmetics, Provisions as to manufacture, sale and purchase of drugs, miscellaneous provisions.

Unit III

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 IV

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. The Motor Vehicles (Amendment) Act, 2019 - 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.

Semester IV

SP I/II/III/IV/V

MFS4RP: Research Project

(As per Specialization)

Marks: 200 **12 Hrs/Week (180 Hrs/Sem)**

'Research Project' being a PRACTICAL course shall be assessed as given in the scheme as per the 'Evaluation Rubrics' mentioned in Annexure III, Eligibility, Guidelines and Scheme of Teaching and Examination for Two Year Master of Science (M.Sc.) Program effective from the academic session 2023-24 and appropriate regulations/guidelines/direction as amended from time to time and as available on the website of RTMNU, Nagpur.

The objective of the research project is to train the learners in identifying the problem of research, perform a comprehensive literature review, develop the hypothesis, design the experiments/surveys to test the hypothesis, collect and analyze the data and draw conclusions from it. In addition, the aim is also to prepare the student to present the data in various forms such as project report, Presentation in conferences and seminar and research/review paper(s). Research project is also aimed to prepare the learner for doctoral research after completion of the programme.