PROGRAM CURRICULUM

(Applicable for the batches admitted from A.Y. 2025-26)

M.Sc. Forensic Science

for

M.Sc. Two Year Degree Program

ADITYA UNIVERSITY

Aditya Nagar, ADB Road, Surampalem - 533 437

ADITYA UNIVERSITY

Vision

- To be a globally recognized university through excellence in Education, Innovation and Sustainable growth.

Mission

Deliver collaborative education to prepare students for global challenges through

- Transformative learning
- Vibrant research ecosystem
- Sustainable and inclusive community

DEPARTMENT OF FORENSIC SCIENCE

Vision

- To be a leading center of forensic science education and research, advancing justice through scientific excellence, innovation, and interdisciplinary collaboration.

Mission

- M1: Transformative, hands-on forensic education fostering critical thinking, ethics and rigor.
- M2: Interdisciplinary research ecosystem supporting justice and global challenges.
- M3: Sustainable and inclusive community of globally competent professionals.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

Graduates of the Program will

PEO1: Advanced Expertise and Leadership
Postgraduates will develop advanced scientific and technical expertise, demonstrating leadership, professional competence, and innovation in forensic science, cyber security, digital forensics, and allied fields.

PEO2: Research, Innovation, and Entrepreneurship
Postgraduates will contribute to knowledge creation and problem-solving through interdisciplinary research, innovation, and entrepreneurial ventures that address emerging challenges in justice, security, and technology.

PEO3: Lifelong Learning, Global Engagement, and Ethical Practice
Postgraduates will pursue lifelong learning, adapt to evolving global trends, and uphold ethical responsibility, integrity, and sustainability in professional and personal endeavors.

PROGRAMME SPECIFIC OUTCOMES (PSO)

After successful completion of the program, the graduates will be able to

PSO1: Advanced Technical Expertise and Research
Demonstrate advanced knowledge and technical skills to analyse forensic or digital evidence. Apply research methods, critical thinking, and problem-solving to address complex challenges and communicate results effectively.

PSO2: Ethical, Legal, and Professional Practice
Conduct forensic or digital investigations with integrity. Adhere to ethical principles, legal standards, and professional practices while ensuring proper handling and documentation of evidence.

PROGRAM OUTCOME (PO)

After successful completion of the program, the graduates will be able to

PO1: Interdisciplinary Scientific and Technological Competence
Integrate advanced concepts from life sciences, physical sciences, computer science, and engineering to analyze, interpret, and solve complex forensic and cybersecurity problems using domain-specific tools and methodologies.

PO2: Crime Scene and Digital Evidence Management
Demonstrate mastery in handling physical and digital evidence through systematic crime scene investigation, documentation, preservation, and chain-of-custody maintenance, ensuring scientific accuracy and legal admissibility.

PO3: Analytical, Instrumental, and Technical Proficiency
Operate, calibrate, and interpret data from advanced forensic and digital instruments—such as GC-MS, LC-MS, FTIR, PCR, network analyzers, and intrusion detection systems—for precise and reliable evidence examination.

PO4: Legal, Ethical, and Regulatory Compliance
Apply sound understanding of criminal law, cyber law, intellectual property rights, and ethical principles to ensure lawful, unbiased, and professional conduct in forensic examinations, digital investigations, and courtroom procedures.

PO5: Advanced Problem-Solving and Critical Thinking
Employ scientific reasoning, data analytics, and computational logic to identify, assess, and resolve complex issues related to crime reconstruction, cyber threats, toxicological findings, and digital vulnerabilities.

PO6: Research, Innovation, and Emerging Technologies
Engage in independent and collaborative research to explore emerging fields such as nanotechnology, AI in cybersecurity, quantum cryptography, forensic genomics, and digital steganography, contributing to scientific innovation and global knowledge.

PO7: Forensic Documentation, Reporting, and Expert Testimony
Develop the ability to prepare precise, structured, and legally sound forensic reports, digital investigation summaries, and expert opinions; demonstrate clarity and confidence in presenting findings in judicial and investigative settings.

PO8: Cyber and Digital Forensics Competence
Acquire advanced skills in digital evidence recovery, malware analysis, ethical hacking, and network forensics using professional tools such as Wireshark, Metasploit, IDA Pro, and forensic imaging software for investigative and preventive cybersecurity applications.

PO9: Behavioral, Environmental, and Societal Forensics Awareness
Apply principles of psychology, criminology, environmental forensics, and wildlife protection to investigate behavioral patterns, ecological crimes, and societal impacts of technology-enabled offenses.

PO10: Communication, Collaboration, and Professional Leadership
Exhibit professional communication skills and collaborate effectively in multidisciplinary teams comprising scientists, technologists, investigators, and legal experts; demonstrate leadership, accountability, and adaptability in dynamic forensic and cybersecurity environments.

PO11: Lifelong Learning, Employability, and Societal Responsibility
Commit to continuous learning and professional development through advanced certifications, workshops, and research; apply forensic and cybersecurity expertise to promote justice, data security, and public welfare in a rapidly evolving digital society.

Department of Forensic Science

M.Sc. (Forensic Science) Program Curriculum – 2025

(Applicable for the students submitted from the A.Y. 2025-26)

PG Programs Offered

- Masters in Forensic Science
- M.Sc. in Cyber Security & Digital Forensics.

Credit Division Category-wise

Sr. No.	Broad Category of Course	Credits
1	Major Core Courses (MCC)	48
2	Minor Stream Courses (MSC)	24
3	Summer Internship (SI)	2
3	Skill Enhancement Courses (SEC)	10
4	Internships (INT)	08
5	Major Project (MJP)	08
Total Credits to be earned for M.Sc. Degree		**100**

Major Core Courses (MCC)

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2511FS33	I	Forensic Science & Criminalistics	FC	3		1	4	50	50	100	-
2511FS34		Criminology and Criminal Laws	FC	3		1	4	50	50	100	-
2511FS39		Questioned Document & Fingerprint Science	IC	2		2	4	50	50	100	-
2511FS40		Forensic Biology, Serology & DNA Fingerprinting	IC	2		2	4	50	50	100	-
2511FS41		Forensic Chemistry	IC	3		1	4	50	50	100	-
2511FS42		Digital & Cyber Forensics	IC	2		2	4	50	50	100	-
2511FS43	II	Forensic Physics & Ballistics	IC	2		2	4	50	50	100	-
2511FS44		Forensic Psychology & Criminology	IC	3		1	4	50	50	100	-
2511FS45		Forensic Toxicology & Pharmacology	IC	3		1	4	50	50	100	FC
2511FS46		Forensic Medicine, Anthropology and Odontology	IC	2		2	4	50	50	100	FBS & DFP
2511FS47		Instrumentation and Analytical Techniques	IC	2		2	4	50	50	100	FC
2511FS48		Multimedia Forensics	IC	3		1	4	50	50	100	D & CF
Total				**28**		**18**	**48**				

Minor Stream in MSC

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
Forensic Biology & DNA Fingerprinting											
2511FS01	III	Advanced Forensic Biology and Serology	AC	2		2	4	50	50	100	FBS & DFP
2511FS02		Wildlife Forensics & Entomology	AC	3		1	4	50	50	100	-
2511FS03		Advanced DNA Profiling	AC	2		2	4	50	50	100	-
2511FS04		Advanced Forensic Genetics & Bioinformatics	AC	3		1	4	50	50	100	-
2511FS05		Advanced Forensic Microbiology & Biotechnology	AC	2		2	4	50	50	100	-
2511FS06		Advanced Biochemistry & Human Physiology	AC	3		1	4	50	50	100	FMA & O
Total				**15**		**9**	**24**				

Minor Stream in Forensic Chemistry & Toxicology											
2511FS07	III	Poisons and Pesticides	AC	2		2	4	50	50	100	FT& PH
2511FS08		Drug and Drug Mechanisms	AC	3		1	4	50	50	100	-
2511FS09		Explosives	AC	2		2	4	50	50	100	FC
2511FS10		Fire, Arson & Petroleum Products	AC	3		1	4	50	50	100	-
2511FS11		Food and Beverages	AC	2		2	4	50	50	100	-
2511FS12		Forensic Nanotechnology	AC	3		1	4	50	50	100	-
Total				**15**		**9**	**24**				

Minor Stream in Questioned Document & Fingerprint Science											
2511FS13	III	Advanced Handwriting & Signature Examination	AC	2		2	4	50	50	100	QD &FP
2511FS14		Advanced Document Forgery Analysis	AC	3		1	4	50	50	100	-
2511FS15		Paper & Ink Analysis	AC	2		2	4	50	50	100	-
2511FS16		Advanced Fingerprint Development & Ridgeology	AC	3		1	4	50	50	100	-
2511FS17		Advanced Fingerprint Examination	AC	2		2	4	50	50	100	-
2511FS18		Advanced Impression Evidence Analysis	AC	3		1	4	50	50	100	-
Total				**15**		**9**	**24**				

Minor Stream in Forensic Physics & Ballistics											
2511FS19	III	Advanced Firearm and Ammunition Analysis	AC	2		2	4	50	50	100	FP & B
2511FS20		Advanced Forensic Wound Ballistics	AC	3		1	4	50	50	100	-
2511FS21		Computational and Experimental Ballistics	AC	2		2	4	50	50	100	-
2511FS22		Structural Failure Analysis and Forensic Engineering	AC	3		1	4	50	50	100	-

2511FS23		Forensic Audio Analysis	AC	2		2	4	50	50	100	-
2511FS24		Instrumental and Analytical Techniques in Forensic Physics & Ballistics	AC	3		1	4	50	50	100	IN & AT
Total				**15**		**9**	**24**				

Minor Stream in Digital Forensics											
2511FS25	III	Advanced Digital Forensics	AC	2		2	4	50	50	100	D &CF
2511FS26		Cyber Law & Incident Response Management	AC	3		1	4	50	50	100	-
2511FS27		Cloud & IoT Forensics	AC	2		2	4	50	50	100	-
2511FS28		Mobile Forensics	AC	3		1	4	50	50	100	-
2511FS29		Network Forensics	AC	2		2	4	50	50	100	-
2511FS30		Reverse Engineering & Malware Analysis	AC	3		1	4	50	50	100	-
Total				**15**		**9**	**24**				

Skill Enhancement Courses (SEC)

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2511FS35	I	IT Skills	FC			2	2	50	50	100	-
2511FS36	II	Courtroom Testimony	FC	2			2	50	50	100	FS & C
2511FS37	III	Research Methodology & Scientific Writing	FC	4			4	50	50	100	-
2511FS38	IV	Student Activity Based Learning	FC				2	100	-	100	-
Total				**6**		**2**	**10**				

Summer Internship (SI)

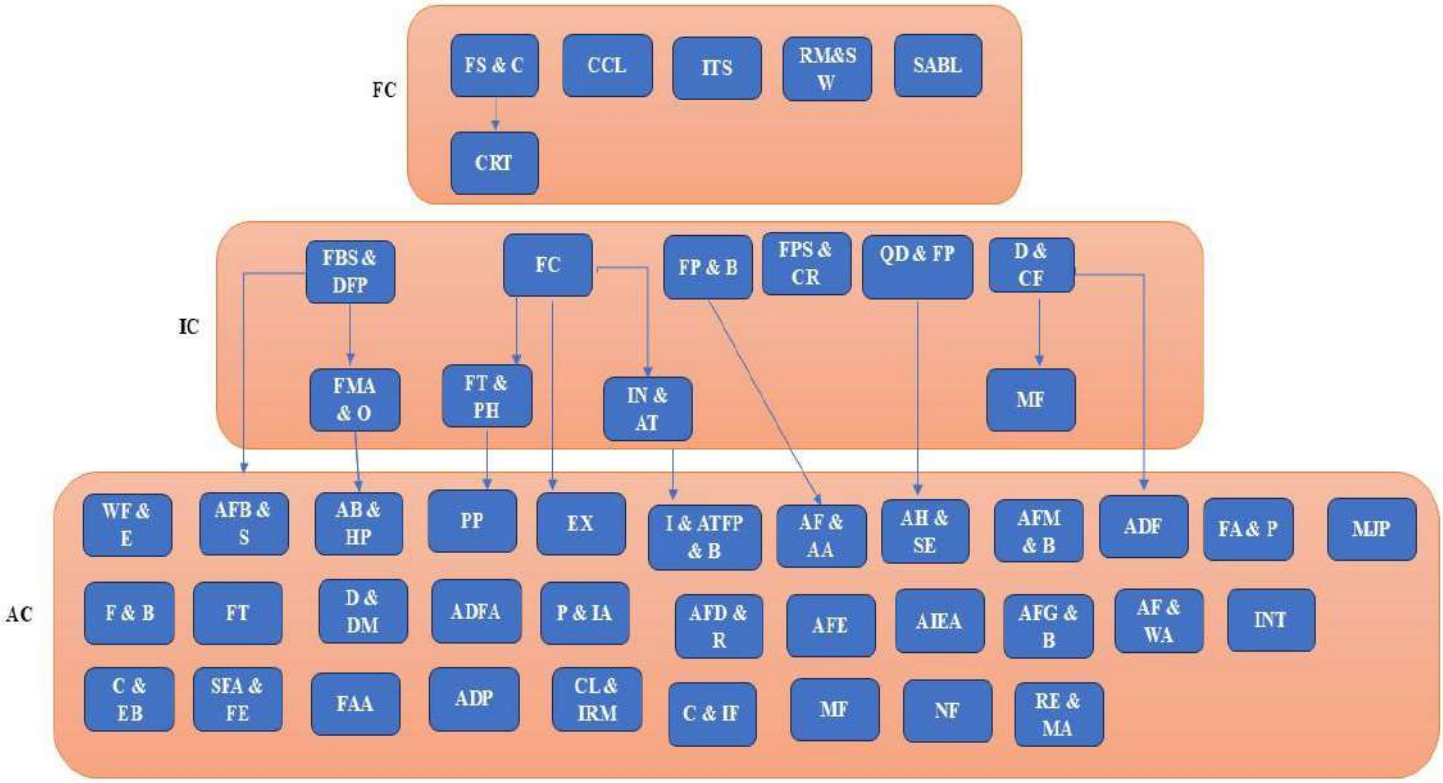
Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2511FS49	III	Summer Internship	AC			2	2	100	-	100	-
Total						**2**	**2**				

Internships (INT)

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2511FS31	IV	Internship	AC			8	8	100	-	100	-
Total						**8**	**8**				

Major Project (MJP)

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2511FS32	IV	Major Project	AC			8	8	50	50	100	-
Total						**8**	**8**				


FC
FS & C
CCL
ITS
RM&SW
SABL
CRT
IC
FBS & DFP
FC
FP & B
FPS & CR
QD & FP
D & CF
FMA & O
FT & PH
IN & AT
MF
AC
WF & E
AFB & S
AB & HP
PP
EX
I & ATFP & B
AF & AA
AH & SE
AFM & B
ADF
FA & P
MJP
F & B
FT
D & DM
ADFA
P & IA
AFD & R
AFE
AIEA
AFG & B
AF & WA
INT
C & EB
SFA & FE
FAA
ADP
CL & IRM
C & IF
MF
NF
RE & MA

FS & C	Forensic Science & Criminalistics
CCL	Criminology and Criminal Laws
QD & FP	Questioned Document & Fingerprint Science
FBS & DFP	Forensic Biology, Serology & DNA Fingerprinting
FC	Forensic Chemistry
D & CF	Digital & Cyber Forensics
FP & B	Forensic Physics & Ballistics
FPS & CR	Forensic Psychology & Criminology
FT & PH	Forensic Toxicology & Pharmacology
FMA & O	Forensic Medicine, Anthropology and Odontology
IN & AT	Instrumentation and Analytical Techniques
MF	Multimedia Forensics

AFB & S	Advanced Forensic Biology and Serology
WF & E	Wildlife Forensics & Entomology
ADP	Advanced DNA Profiling
AFG & B	Advanced Forensic Genetics & Bioinformatics
AFM & B	Advanced Forensic Microbiology & Biotechnology
AB & HP	Advanced Biochemistry & Human Physiology
PP	Poisons and Pesticides
D & DM	Drug and Drug Mechanisms
EX	Explosives
FA & P	Fire, Arson & Petroleum Products
F & B	Food and Beverages
FT	Forensic Nanotechnology
AH & SE	Advanced Handwriting & Signature Examination
ADFA	Advanced Document Forgery Analysis
P & IA	Paper & Ink Analysis
AFD & R	Advanced Fingerprint Development & Ridgeology
AFE	Advanced Fingerprint Examination
AIEA	Advanced Impression Evidence Analysis
AF & AA	Advanced Firearm and Ammunition Analysis
AF & WA	Advanced Forensic Wound Ballistics
C & EB	Computational and Experimental Ballistics
SFA & FE	Structural Failure Analysis and Forensic Engineering
FAA	Forensic Audio Analysis
I & ATFP & B	Instrumental and Analytical Techniques in Forensic Physics & Ballistics
ADF	Advanced Digital Forensics
CL & IRM	Cyber Law & Incident Response Management
C & IF	Cloud & IoT Forensics
MF	Mobile Forensics
NF	Network Forensics
RE & MA	Reverse Engineering & Malware Analysis

SKILL ENHANCEMENT COURSES

SEC	Skill Enhancement Courses
ITS	IT Skills
CRT	Courtroom Testimony
RM&SW	Research Methodology & Scientific Writing
SABL	Student Activity Based Learning

INTERNSHIP

SI	Summer Internship

INTERNSHIP

INT	Internship

MAJOR PROJECT

MJP	Major Project

Semester-wise Curriculum

I SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2511FS33	Forensic Science & Criminalistics	MCC	FC	3		1	4	5
2511FS34	Criminology and Criminal Laws	MCC	FC	3		1	4	5
2511FS39	Questioned Document & Fingerprint Science	MCC	IC	2		2	6	5
2511FS40	Forensic Biology, Serology & DNA Fingerprinting	MCC	IC	2		2	6	5
2511FS41	Forensic Chemistry	MCC	IC	3		1	4	5
2511FS42	Digital & Cyber Forensics	MCC	IC	2		2	6	5
2511FS35	IT Skills	SEC	FC	0		2	2	4
	Total			**15**		**11**	**29**	**34**

II SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2511FS43	Forensic Physics & Ballistics	MCC	IC	2		2	6	5
2511FS44	Forensic Psychology & Criminology	MCC	IC	3		1	4	5
2511FS45	Forensic Toxicology & Pharmacology	MCC	IC	3		1	4	5
2511FS46	Forensic Medicine, Anthropology and Odontology	MCC	IC	2		2	6	5
2511FS47	Instrumentation and Analytical Techniques	MCC	IC	2		2	6	5
2511FS48	Multimedia Forensics	MCC	IC	3		1	4	5
2511FS36	Courtroom Testimony	SEC	FC	2		0	2	2
	Total			**17**		**9**	**29**	**32**

III SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
	Minor Stream Course – 1	MSC	AC	2		2	4	6
	Minor Stream Course – 2	MSC	AC	3		1	4	5
	Minor Stream Course – 3	MSC	AC	2		2	4	6
	Minor Stream Course – 4	MSC	AC	3		1	4	5
	Minor Stream Course – 5	MSC	AC	2		2	4	6
	Minor Stream Course – 6	MSC	AC	3		1	4	5
2511FS37	Research Methodology & Scientific Writing	SEC	FC	4			4	4
2511FS49	Summer Internship	SI				2	2	20
	Total			**19**		**11**	**30**	**57**

IV SEMESTER

Course code	Course Title	Course		Credits				Total Hours
		Category	Level	L	T	P	Total	
2511FS31	Internship	INT	AC			8	8	20
2511FS32	Major Project	MJP	AC			8	8	20
2511FS38	Student Activity Based Learning	SEC	FC				2	-
	Total					**16**	**18**	**40**

Total Credits: 100

M.Sc. Forensic Science

Major Core Courses (MCC)

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2511FS33	I	Forensic Science & Criminalistics	FC	3		1	4	50	50	100	-
2511FS34		Criminology and Criminal Laws	FC	3		1	4	50	50	100	-
2511FS39		Questioned Document & Fingerprint Science	IC	2		2	4	50	50	100	-
2511FS40		Forensic Biology, Serology & DNA Fingerprinting	IC	2		2	4	50	50	100	-
2511FS41		Forensic Chemistry	IC	3		1	4	50	50	100	-
2511FS42		Digital & Cyber Forensics	IC	2		2	4	50	50	100	-
2511FS43	II	Forensic Physics & Ballistics	IC	2		2	4	50	50	100	
2511FS44		Forensic Psychology &	IC	3		1	4	50	50	100	-

		Criminology									
2511FS45		Forensic Toxicology & Pharmacology	IC	3		1	4	50	50	100	FC
2511FS46		Forensic Medicine and Anthropology and Odontology	IC	2		2	4	50	50	100	FBS & DFP
2511FS47		Instrumentation and Analytical Techniques	IC	2		2	4	50	50	100	FC
2511FS48		Multimedia Forensics	IC	3		1	4	50	50	100	D & CF
Total				**30**		**18**	**48**				

Forensic Science and Criminalistics

Course Code: 2511FS33
Semester - I
Course Outcomes:

L	T	P	C
3	0	1	4

At the end of the course, students will be able to:

CO1: Demonstrate an understanding of forensic science and its key domains, including criminalistics, forensic biology, and digital forensics.

CO2: Identify the roles and functions of national and international forensic institutions and agencies.

CO3: Apply crime scene processing techniques, including documentation, photography, and 3D scanning.

CO4: Handle and preserve evidence in accordance with legal standards and best practices.

CO5: Analyze and reconstruct crime scenes, and produce accurate forensic reports in compliance with legal and ethical standards.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1	2	2	-	1	3	2	-	2
CO2	-	1	3	-	-	-	1	-	-	-	2
CO3	2	3	2	2	3	-	2	-	-	-	2
CO4	-	3	3	2	2	-	2	-	-	-	2
CO5	2	3	3	2	3	-	3	-	-	-	3

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	2
CO2	1	2
CO3	2	2
CO4	1	2
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Fundamentals of Forensic Science.

Introduction, Definition, Significance and Scope of Forensic Science. History and Development: Contributions of forensic scientists in India and globally. Principles of Forensic Science. Domains of Forensic Science: Criminalistics, Domains of Forensic Science - Forensic Biology, Serology and DNA Fingerprinting, Forensic Chemistry and Toxicology, Forensic Physics and Ballistics, Forensic Fingerprint and Questioned Document Examination, Forensic Medicine and Anthropology, Forensic Odontology and Osteology, Wildlife and Environmental Forensics, Forensic Engineering, Forensic Psychology and Behavioral Science, Digital and Cyber Forensics and Forensic Accounting.

Practice - Processing of general Crime Scene (Homicide & Suicide Case).

UNIT – II: Forensic Institutions and Agencies

Teaching & Research Institutions: National and International Scenario. Forensic Laboratories: Structure and Function of DFSS, CFSL, SFSL, RFSL, MFSL, Facilities in FSL and other allied institutions. National Forensic Institutions in India: NFSU, CDFD, & NDTL. Law Enforcement Agencies & Investigative Bodies: CBI, NIA, CID, IB, RAW, BPR&D, ED, SFIO, NCRB, CISF, & NCB. Training & Data Management Institutions: CDTI, Clues Team, FPB, & OCTOPUS. International Institutions: FBI, CIA, WADA, DEA, INTERPOL, Europol, Ameripol, & Afripol. Ethics and professionalism in Forensic Science Institutions.

Practice - Processing of Fire & Arson Case.

UNIT – III: Crime Scene Processing

Definition and Importance of Crime Scene Processing. Types of Crime Scenes. Steps of Crime Scene Investigation: Initial Response, Safety Procedures, Emergency Care, Securing and Crowd Handling, Crime Scene Boundaries, Initial Walk-Through, Search Patterns, Documentation, Establishing Command Post, Notifications. Crime Scene Documentation: Importance, Types, and Methods. Crime Scene Photography: Techniques, Angles, and Lighting. Crime Scene Videography. Crime Scene Sketching: Types, Components, and Importance. Crime Scene Note-Taking: Characteristics, Elements, and Guidelines. Advanced Documentation Methods: Digital Imaging, 3D Scanning – Types, Advantages, Applications.

Practice - Processing of Road Accident Case.

UNIT – IV: Evidence Handling and Preservation

Definition and Importance of Evidence. Types of Physical Evidence: Class vs. Individual Characteristics. Role of Physical Evidence: Linking Suspects, Victims, and Crime Scenes. Classification of Evidence: Biological Evidence: Blood, semen, saliva, tissues, body fluids. Chemical Evidence: Drugs, poisons, explosives, accelerants. Physical Evidence: Weapons, glass, soil, fibers, paint, non-biological materials. General Principles of Evidence Handling. Admissibility of Evidence in Court. Evidence Collection Techniques: Biological, Chemical,

Physical, Digital, and Trace Evidence. Labeling and Documentation of Evidence. Evidence Preservation Methods. Legal Considerations & Chain of Custody. Challenges & Best Practices in Evidence Management.

Practice - Processing of Digital Crime Scene.

UNIT – V: Crime Scene Reconstruction and Legal Framework

Crime Scene Reconstruction: Principles, Stages, Types, and Classification. Event Reconstruction: Bloodstain Pattern Analysis, Impression Evidence, Shooting Scene. Computer-Assisted Reconstruction. Reconstruction Report Writing: Guidelines, Importance, Nature, Format, Length, Legal Challenges & Considerations. Key Legal Terminologies: Victim, Suspect, Offender, Accused, Convict, Witness, Expert Witness. Legal Standards: Frye Rule and Daubert Standard. Ethics and Professionalism in Forensic Science. Role of Forensic Experts in the Judicial Process. Ethics in Forensic Practice and Expert Testimony. Report Writing & Evidence Presentation: Components of Reports & Report Format (ISO/IEC 17025:2005). Common Reporting Mistakes, Do's & Don'ts.

Practice - Processing of Bomb Blast Scene.

Textbooks:

1. Sharma, B. R. *Forensic Science in Criminal Investigation & Trials.* Universal Law Publishing.
2. Saferstein, R. *Criminalistics: An Introduction to Forensic Science.* Pearson.

Reference Books:

1. Houck, M. M., & Siegel, J. A. *Fundamentals of Forensic Science.* Elsevier.
2. Fisher, B. A. J. *Techniques of Crime Scene Investigation.* CRC Press.

Web Links:

1. https://www.sjsu.edu/people/mary.juno/courses/1066/s8/Intro.pdf?
2. https://www.tn.gov.in/rti/proactive/home/handbook_forensic_sciences.pdf?
3. https://www.fbi.gov/services/laboratory
4. https://nij.ojp.gov/topics/forensic-science
5. https://sites.chemistry.unt.edu/~tgolden/courses/Vol%20I%20Chapter%201%20Legal%20Aspects%20of%20Forensic%20Science.pdf?

Criminology and Criminal Laws

	L	T	P	C
Course Code: 2511FS34				
Semester – I	3	0	1	4

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand criminology concepts, theories, and criminal behaviour.
CO2: Analyze the criminal justice system and court structures in India and globally.
CO3: Classify various criminal offenses and emerging crime trends.
CO4: Examine criminal laws, trial processes, and the role of experts in justice.
CO5: Explore punishment theories, victimology, and prison reforms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	2	-	-	-	3	-	2
CO2	-	-	3	-	2	-	-	-	2	-	2
CO3	-	-	2	-	3	-	-	-	2	-	2
CO4	1	-	3	-	2	-	2	-	2	-	2
CO5	-	-	2	-	2	-	-	-	3	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	1	2
CO3	2	1
CO4	2	2
CO5	1	2

Unit-Wise Syllabus:

UNIT – I: Criminology and Behavioural Analysis

Criminology - Definition, Nature & Scope. Its importance & Objectives. Indian concept of Criminology. Historical Perspective. Radical Criminology. The Schools of Criminology - Pre-classical, Classical, Neoclassical, Positive, Clinical & Sociological School of Criminology. Crime - Definition, Historical perspective, Causes of Crime, Characteristics, Classification, and factors (Atrocity, Seriousness, Motive, Statistical, Situational & Systematic). Crime in India: Present Scenario and Trends. Criminal Behaviour - Introduction. Theories of Criminal Behaviour (Biological, Classical, Sociological & Social disorganization theories of Crime)

Practice - Analysis of Crime Rate Trends in India

UNIT – II: Criminal Justice System & Criminal Law Courts

Introduction to Criminal Justice System: Definition, Objectives, Goals. Principles, Structure in India and other countries, Steps and Administration of Criminal Justice in India. Police organization, structure, and functions. Police powers and limitations (arrest, search and seizure).Police ethics and accountability. Global Models (Adversarial vs. Inquisitorial). International Human Rights and Due Process. Court's Role in Dispensation of Criminal Justice. Criminal Law Courts in Ancient India, Medieval Period, British India, India after Independence - The Supreme Court of India, High Courts, Sessions Courts - Assistant Session Court, Judicial Magistrate Courts.Special Court, Juvenile Courts, Nyaya Panchayats, Lok Adalats, e- Courts, Videoconferencing, Judicial Data Grid, Fast Track Courts and their Functions.

Practice - Study of Organized vs. Disorganized Crimes

UNIT – III: Criminal offences

Criminal Offenses and Classifications: Cognizable vs. Non-Cognizable, Bailable vs. Non-Bailable, Compoundable vs. Non-Compoundable, Felonies vs. Misdemeanors. Crimes - Predatory Crime, Violent Crime, Inchoate Crime, Hate Crime, Crime without a Victim, Organised and Disorganized Crime, White Collar Crime, Cyber Crime, Sexual Offences, Alcoholism & Drug addiction Crime, Human Trafficking.

Practice - Mock Courtroom Trial

UNIT – IV: Criminal Laws and Trial Processes

Criminal Laws and Reforms: Bharatiya Nyaya Sanhita (BNS) - Section 63, 64, 80, 100, 101, 103(1), 110, 138, 170, 173, 293, 294, 295, 309(1)(2)(3), 310(1), 318(4), 332(c), 336(1), and 336(2). Bharatiya Nagarik Suraksha Sanhita (BNSS) - Section 173, 176, 326, 328, 329, 330, 349 and 337. Bharatiya Sakshya Adhiniyam (BSA) - Section 39(1), 40, 41(1), 41(2), 52, 53, 55, 72, 140, 141, 142, and 162. Relationship Between Law, Justice, and Society. Trial Process, Testimony, Evidence Admissibility, Adjudication, Rights of the Accused, Role of Prosecution and Defense, Expert Witnesses, Examination-in-Chief, Cross-Examination, Admissibility of Evidence: BSA and Rules of Evidence.

Practice - To explore victim rights, support services, and their role in criminal justice.

UNIT – V: Penology, Victimology, and Prison Reforms

Penology - Definition, Punishment, Concept of Punishment & its Justification. Theories of Punishment (Deterrent, Retributive, Preventive, Reformative). Forms of Punishment & Judicial Sentencing (Flogging, Mutilation, Branding, Stoning, Pillory, Amercement, Fines, Forfeiture of Property, Collateral Sanctions/Penalty, Security Bond, Ostracism, Blanket Civil Death, Exile, Banishment, Solitary Confinement, Detention, House Arrest, Custodial Sentence, Imprisonment for Life, Death Sentence, Capital Punishment, and Judicial Sentencing). Victimology - Typology, Historical perspective, Victimology Today, Theories, Law Commission of India and other Victim oriented Services. Interrelation between Criminology, Penology & Victimology. Correctional Institutions: Structure and Functioning of Prisons, Juvenile Justice Homes, Open Prisons. Prison Reforms and Human Rights: Nelson Mandela Rules, Indian Prison Reforms, Role of NGOs and Civil Societies.

Practice - To Understand the Role of Non-Governmental Organizations in Prison Reforms

Activities:

1. Report writing on visit to police station
2. Report writing on Court Visit

Textbooks:

1. Houck, M. M., & Siegel, J. A. (2015). *Fundamentals of Forensic Science*. Academic Press.
2. Saferstein, R. (2021). *Criminalistics: An Introduction to Forensic Science*. Pearson.

Reference Books:

1. Bertino, A. J. (2018). *Forensic Science: Fundamentals and Investigations*. Cengage Learning.
2. Bell, S. (2019). *Forensic Chemistry*. Pearson.

Web Links:

1. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001608/P001744/M027830/ET/1521104098StructureofCriminalJusticeSysteminIndiaEPG%282.pdf?https://www.forensicsciencesociety.co.uk
2. https://www.fbi.gov/services/laboratory
3. https://www.aafs.org
4. https://www.fbi.gov/services/laboratory

Questioned Document & Fingerprint Science

Course Code: 2511FS39
Semester – I
Course Outcomes:

L	T	P	C
2	0	2	4

At the end of the course, students will be able to:

CO1: To provide fundamental knowledge of questioned documents, fingerprint science, and impression evidence.
CO2: To understand the history, principles, and forensic significance of handwriting, fingerprints, and impression evidence.
CO3: To develop skills in recognizing, analyzing, and preserving different types of forensic evidence.
CO4: To explore legal aspects, admissibility, and challenges in forensic document and fingerprint examination.
CO5: To familiarize students with recent advancements, including AI, biometric systems, and forensic databases.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	3	2	-	-	-	-	-	2
CO2	3	2	-	2	2	-	-	-	-	-	1
CO3	2	3	2	3	3	-	2	-	-	-	2
CO4	-	2	3	2	2	-	3	-	-	-	2
CO5	2	1	-	2	2	2	-	3	-	-	3

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	2	1
CO3	2	2
CO4	1	2
CO5	2	1

Unit-Wise Syllabus:

UNIT – I: Fundamentals of Questioned Document Examination

History and development of questioned document examination, Nature and scope of questioned document examination, Types of questioned documents, Basic principles of handwriting identification, Class and individual characteristics in handwriting, Factors affecting handwriting, Influence of writing instruments and surfaces, Natural and simulated forgeries, Disguised and anonymous writings, Line quality defects and tremors, Role of forensic document examiner in criminal investigations.

Practice - To examine class and individual characteristics in given handwriting samples.

UNIT – II: Forensic Analysis of Forgery and Document Alterations

Definition of Forgery, Handwriting Forgery – Traced, Freehand, Simulated, Disguised Writing, Signature Forgery – Imitation, Alteration, Digital Forgery, Factors Influencing Forgery – Writing Conditions, Disguise, Illness, Aging, Forgery Detection Techniques – Handwriting Comparison, Pressure Analysis, Line Quality Examination.

Types of Document Alterations – Erasures, Additions, Overwriting, Obliterations. Examination of Alterations by using VSC (Video Spectral Comparator), ESDA (Electrostatic Detection Apparatus), Analysis of paper & Ink by using various tools and techniques.

Practice - To detect various types of alteration and forgery in a given document.

UNIT – III: Basics of Fingerprint Science

History and development of fingerprint science, Nature and importance of fingerprints, Fundamental principles of fingerprints, Types of fingerprints- rolled, plain, chance, latent, patent and plastic, Patterns of Fingerprints, Classification of fingerprint patterns, Henry's classification system, Ridge characteristics (Minutiae), Role of genetics in fingerprint patterns, Mechanism of fingerprint deposition, Comparison and matching techniques, Automated Fingerprint Identification System (AFIS).

Practice - To study the various types of classification in fingerprints.

UNIT – IV: Techniques for Fingerprint Development and Analysis

Non-destructive methods for fingerprint development, Chemical methods for fingerprint development, Enhancement techniques for latent fingerprints, Lifting and comparison of impression evidence, Basic digital tools for fingerprint and impression analysis, Powder methods for fingerprint visualization, Cyanoacrylate (superglue) fuming, Ninhydrin and DFO treatments, Small particle reagent method, Fluorescent and alternate light source techniques, DNA analysis from fingerprint residues, Role of biometric systems in fingerprint identification.

Practice - To develop latent fingerprints using physical and chemical methods.

UNIT – V: Impression Evidence

Definition of impression evidence, Nature and importance of impression evidence, Types of impression evidence, Collection and preservation of impression evidence, Class and individual characteristics in impression evidence, Methods of comparison and analysis, Palm prints, Shoeprints and gait pattern analysis, Tire marks and vehicle impression evidence, Tool marks and forensic examination, Bite mark evidence and forensic odontology, Lip prints and their forensic significance, Ear prints and their forensic applications, Casting and lifting techniques in impression evidence.

Practice - To perform casting of impression evidence.

Textbooks:

1. Hilton, O. (1993). *Scientific examination of questioned documents (Revised ed.).* CRC Press.
2. Kelly, J. S., & Lindblom, B. S. (2006). *Scientific examination of questioned documents (2nd ed.).* CRC Press.

Reference Books:

1. Ellen, D. (2005). *Scientific examination of documents: Methods and techniques (3rd ed.).* CRC Press.
2. Morris, R. N. (2000). *Forensic handwriting identification: Fundamental concepts and principles.* Academic Press.

Web Links:

1. https://nij.ojp.gov/library/publications/fingerprint-sourcebook
2. https://www.gutenberg.org/ebooks/19022
3. https://www.swgdoc.org
4. https://www.theiai.org
5. https://www.aafs.org

Forensic Biology, Serology & DNA Fingerprinting

Course Code: 2511FS40
Semester – I
Course Outcomes:

L	T	P	C
2	0	2	4

At the end of the course, students will be able to:

CO1: Understand fundamental concepts of cell biology, metabolism, and human physiology with forensic applications.
CO2: Analyze immunological principles, antigen-antibody interactions, and blood group systems in forensic investigations.
CO3: Examine forensic serological techniques for identifying biological fluids and species differentiation.
CO4: Utilize forensic botany and microscopic analysis of hair, fibers, diatoms, and toxic plants in evidence examination.
CO5: Apply DNA profiling techniques, including STR, SNP, mtDNA, and forensic databases, for human identification.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	2	2	-	-	-	-	-	-
CO2	3	2	-	2	1	-	-	-	-	-	-
CO3	3	3	-	3	2	-	1	-	-	-	-
CO4	2	3	-	3	2	-	1	-	-	2	-
CO5	3	2	-	3	3	1	2	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	2	1
CO3	2	1
CO4	2	1
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Essentials of Biology

Cell Biology – Prokaryotic vs. Eukaryotic Cells, Structure & Functions of Organelles, Structure and Organization of Cytoskeleton and Cell Movements, Cell Cycle & Regulation. Cellular Respiration & Metabolism – Glycolysis, Kreb Cycle, Electron Transport Chain (ETC), Oxidative Phosphorylation. Biomolecules & Their Forensic Relevance – Proteins, Lipids, Carbohydrates, Nucleic Acids, DNA & RNA Structure.

Practice - Presumptive and Confirmatory Tests for Biological Fluids.

UNIT – II: Immunity, Immunomolecules, and Blood Forensics

Cells and Organs of the Immune system. Types of Immunity – Innate, Acquired, Passive, Active, and Autoimmunity. Definition, Basic Properties, and Types of Antigen. B and T-Cell epitopes. Definition, Structure, Classes, and Function of Antibodies. Factors influencing Immunogenicity and Antigenicity. Molecular Basis of Antigen-Antibody Interaction – Epitope-Antibody Binding. Blood Groups and Their Significance – ABO, Rh, MN, Secretor & Non-Secretor Status, Bombay Phenotype, Lewis & Kell Systems. Blood Spatter Analysis – Pattern Analysis, Angle of Impact, Velocity Classification, and Forensic Interpretation. General introduction to vaccines.

Practice - ABO and Rh Blood Group Determination.

UNIT – III: Serological Evidence Analysis

Definition, Scope, and Classification Based on Class and Individual Characteristics. Forensic Examination of Biological Fluids - Blood, Semen, Saliva, Urine, Vaginal Secretions, Feces, Sweat, Tissues, Bones, and Teeth. Species Differentiation - Molecular and Immunological Techniques. Comparative Evaluation of Presumptive and Confirmatory Assays for Body Fluid Identification. Primary and Secondary Binding Assays in Serological Analysis.

Practice - Microscopic Examination and Differentiation of Hair and Fiber samples.

UNIT – IV: Biological and Trace Evidence Analysis

Definition, Scope of Forensic Biology. Hair - Structure, Composition, Growth, Identificationand Comparison between Human and Animal Hair – Morphological & Microscopic Differences. Cuticle, Cortex, Medulla Analysis, Hair Damage & Dye Detection. Fiber Classification, Physical & Chemical Analysis. Diatoms & Palynology (Pollen Analysis) in Forensic Science - Collection, Extraction, Identification, and Diatom Database. Role of Pollen Grains in Locard's Exchange Principle. Forensic Botany & Poisonous Plants - Toxic Plants & Their Active Compounds (*Ricinus, Abrus, Datura, Aconitum*).

Practice - Diatom Identification under Microscope.

UNIT – V: Basics of DNA Profiling

Discovery, Composition and structural differences between prokaryotic and eukaryotic genetic material, Molecular Structure and Function of DNA & RNA. Central Dogma of Life. Extraction & Separation techniques of DNA. DNA Quantification - Southern Blotting, PCR, FID. DNA Profiling Techniques – VNTRs, RFLP, STRs, SNPs, Specialized DNA Analysis Methods – mtDNA, Y-Chromosome and X-Chromosome STR Analysis. DNA Databases and Forensic Databanks - National and International DNA Databases – CODIS (USA), NDDB (India). Ethical and Legal Considerations – Privacy concerns, retention policies, and misuse prevention, Human Genome Project, and DNA Regulation Bill, 2019.

Practice - DNA extraction and analysis using Gel Electrophoresis.

Textbooks:

1. Forensic Biology by Richard Li.
2. Fundamentals of Forensic DNA Typing by John M. Butler.
3. Forensic Serology by RJ Williams.
4. Textbook of Immunology by Kuby.
5. Essentials of Forensic Biology by Alan Gunn.

Reference Books:

1. Advanced Forensic Biology by Ashraf Mozayani and Carla Noziglia.
2. Molecular Biology in Forensic Science by James R. Robertson.

Web Links:

1. https://www.ncbi.nlm.nih.gov/?utm
2. https://www.cfsre.org/research/forensic-biology?utm
3. https://forensiccoe.org/forensicbiology-dna/?utm
4. https://www.cdfd.org.in/?utm
5. https://nij.ojp.gov/topics/forensics/forensic-biology-forensic-dna?utm

Forensic Chemistry

Course Code: 2511FS41
Semester – I
Course Outcomes:

L	T	P	C
3	0	1	4

At the end of the course, students will be able to:

CO1: Understand fundamental principles of forensic chemistry, including chemical analysis and its application to forensic evidence, Role of Forensic Chemist in Court proceedings.
CO2: Analyze controlled substances, narcotics, and psychotropic drugs using chemical and instrumental methods under the NDPS Act.
CO3: Gain expertise in the classification, chemistry, and forensic investigation of explosives, including post-blast residue analysis.
CO4: Investigate fire and arson cases by understanding fire patterns, thermodynamics, and the analysis of fire debris and petroleum products.
CO5: Conduct forensic analysis of food and beverages, identifying adulterants and ensuring compliance with food safety regulations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	3	2	-	2	-	-	-	-
CO2	3	2	2	3	2	-	1	-	-	-	-
CO3	3	2	2	3	2	-	1	-	-	-	-
CO4	3	3	2	3	3	-	1	-	-	1	-
CO5	3	2	2	2	2	-	1	-	-	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	2	1
CO3	2	1
CO4	2	1
CO5	2	1

Unit-Wise Syllabus:

UNIT – I: Introduction to Forensic Chemistry

Forensic Chemistry and its Scope, Analysis of Beverages: Alcohol and Non- Alcoholic, Country Made Liquor etc. Adulterated food material. Drugs of Abuse: Introduction, Classification, Narcotic Drugs & Psychotropic Substances, Sampling, Specific Drugs Types (Cannabis, Heroin, Cocaine, Amphetamine), Drugs of Abuse in Sports. Brief Introduction to Drugs and Cosmetic Act, Excise Act, NDPS Act. An Overview of Clandestine Laboratories. Trap Cases: Purpose, Examination of Chemicals Used in Trap Case.

Practice - Qualitative and Quantitative analysis of Narcotic Drugs and Psychotropic Substances by colour tests, and Instrumental techniques.

UNIT – II: Examination of Petroleum and Food products

Examination of Petroleum Products: Distillation & Fractionation, Various Fractions and their Commercial Uses. Standard Methods of Analysis of Petroleum Products for Adulteration. Introduction to Alcoholic and non-alcoholic beverages, Analysis of alcoholic beverages, country made liquor, illicit liquor and medicinal preparations containing alcohol as constituents, Analysis of non-alcoholic beverages like tea, coffee. Adulterated Food Analysis: Common adulterants in food, Analysis of samples taken under Food Adulteration Act, and case studies.

Practice - Analysis of NSAID drugs by UV and TLC.

UNIT – III: Fire and Arson

Introduction to Fires, Types of Fires, and Causes of fire, Patterns of fire, Thermodynamics of fire, Accelerants and incendiary devices, Forensic Analysis of Fire Debris by Instrumental methods, Introduction, Forensic Analysis, and adulteration in petroleum products as per BIS Specifications. Arson: Relevant BNS Sections, Motives, Analysis of Accelerants.

Practice - Examinations of petroleum products as per BIS specifications.

UNIT – IV: Explosives

Introduction to Explosives: Devices, Explosives Classification, Detonation & Deflagration, Primary and Secondary Explosives, Comparison & Characterization of Explosives, Military & Commercial Explosives, Detection of Anions, Detection of Black Powder, Nitrocellulose and Dynamite, Quantitative Determination. Energy Release, Explosive Output, Critical Diameter, Chemistry of Some Common Explosives, Military Explosives, Plastic Explosive, Commercial Explosives, Propellants, Terrorist use if Homemade Explosives, Peroxide Explosives, Exotic Explosives, Energetic Salts. Non – Solid Explosives, Detection of Explosives by Dogs, Colorimetric Detection of Explosives, X – Ray Technologies.

Practice - Analysis of phenolphthalein in bribe cases.

UNIT – V: Recent trends in Forensic Chemistry

Current research and developments in the field of forensic chemistry and its interdisciplinary areas. Forensic Nanotechnology: Basic principles & theories, Synthesis, characterization of Nanoparticles, applications in Forensic science. Chemo – metrics & Statistics, CBRN analysis, Sports Forensics. Forensic nuclear chemistry: Introduction to nuclear forensics, nuclear threats, Nuclear explosive devices, Radioactivity, Radioactive decay rates and Half-lives, Methods of detection and measurement of radioactivity (G.M and Scintillation Counter), Applications of Radioisotopes, Nuclear Magnetic Resonance (NMR).

Practice - Analysis of food samples by chemical methods.

Textbooks:

1. Skoog D.A. West D.M. & Holler F.J. (2000). Analytical Chemistry– An Introduction. USA, Saunders College Pub.
2. Dettean J. D. (2002). Kirk's Fire Investigation. NY, Prentice Hall, Eaglewood Cliffs, w.e.f.

Reference Books:

1. Boudreau JE, Etal; Arson & Arson Investigation, Survey & Assessment National Institutes Of Law Enforcement, U.S. Deptt Of Justice, U.S. Govt Printing Press.
2. Working Procedure Manual – Chemistry, Explosives And Narcotics, BPR&D Pub.

Web Links:

1. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_pg/692
2. https://www.sciencedirect.com/journal/forensic-chemistry
3. http://ndl.iitkgp.ac.in/he_document/inflibnet_epgp/IN__I_e_P_P__1_F_S__16151_P_0_F_C_a_E__16513_M_3_S_A_t_S_o_E_P_B_R_C_P_A_F_O_E_E__16543_16544
4. https://nij.ojp.gov/topics/articles/advances-detecting-and-identifying-explosives-after-attack?utm_
5. https://forensicscience.ufl.edu/programs/courses/chemistry-of-explosive-materials/?utm

Digital & Cyber Forensics

Course Code: 2511FS42
Semester - I
Course Outcomes:

L	T	P	C
2	0	2	4

At the end of the course, students will be able to:

CO1: Conduct advanced forensic analysis of digital devices, cloud environments, and encrypted systems.
CO2: Develop methodologies for identifying and mitigating cyber threats, including zero-day vulnerabilities.
CO3: Implement forensic automation using scripting and AI-based forensic techniques.
CO4: Analyze and reconstruct cybercrime scenarios using live forensics, memory forensics, and malware analysis.
CO5: Apply legal, ethical, and regulatory frameworks to forensic investigations and expert witness testimony.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	2	2	-	1	3	-	-	-
CO2	3	2	-	2	3	2	-	3	-	-	-
CO3	2	2	-	3	3	2	-	3	-	-	-
CO4	3	3	-	3	3	-	1	3	-	-	-
CO5	2	2	3	1	2	-	3	2	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	2	1
CO3	2	1
CO4	2	1
CO5	2	1

Unit-Wise Syllabus:

UNIT – I: Advanced Digital Evidence Acquisition & Preservation

Digital forensic principles, advanced forensic imaging, and evidence acquisition methodologies. Live forensics vs. dead forensics, volatile and non-volatile data collection, forensic triage. Advanced disk forensics: SSD forensics, hybrid storage forensics, forensic duplication techniques, and artifact extraction. Role of blockchain in digital evidence authentication and forensic integrity. Anti-forensics techniques and countermeasures.

Practice - Creating and analysing a forensic disk image using FTK Imager.

UNIT – II: Cybercrime Investigation & Incident Response

Types of cybercrimes: cyber warfare, state-sponsored cyber-attacks, deepfake forensics, and social engineering attacks. Cybercrime intelligence gathering: Open-Source Intelligence (OSINT) and Dark Web analysis. Advanced log analysis, forensic correlation of event logs, SIEM tools for cyber incident detection. Automated threat intelligence, intrusion detection, and attack attribution techniques. Digital forensic readiness and response planning for cyber incidents.

Practice - Recovering deleted files and metadata with Autopsy.

UNIT – III: Network, Cloud, and IoT Forensics

Advanced network forensics: Deep Packet Inspection (DPI), network intrusion analysis, wireless forensics, VPN traffic analysis, and encrypted traffic investigation. Cloud forensics: forensic data acquisition from AWS, Azure, and Google Cloud, challenges in multi-tenant cloud investigations, and legal considerations in cloud evidence handling. IoT forensics: forensic challenges in smart devices, data extraction from IoT sensors, forensic analysis of industrial control systems (ICS) and SCADA environments.

Practice - Examining network traffic and identifying anomalies using Wireshark.

UNIT – IV: Cryptographic & Malware Forensics

Encryption forensic analysis: forensic decryption techniques, cryptanalysis tools, and steganography detection. Blockchain forensics: cryptocurrency tracking, digital wallet forensics, and NFT fraud investigation. Malware forensics: dynamic and static malware analysis, reverse engineering of malware using IDA Pro and Ghidra, forensic analysis of rootkits, ransomware, and polymorphic malware. AI-driven malware detection techniques.

Practice - Extracting and analyzing mobile data with forensic tools.

UNIT – V: Legal & Ethical Challenges in Digital Forensics

Legal frameworks and international cyber laws: GDPR, CCPA, IT Act, CFAA, and Budapest Convention. Admissibility of digital evidence in court, expert witness testimony, and forensic report writing best practices. Digital rights management (DRM), privacy concerns, and ethical considerations in cyber forensic investigations. Case studies on digital forensic failures and lessons learned from real-world cyber investigations.

Practice - Detecting hidden information in images using steganalysis techniques.

Textbooks:

1. "Incident Response & Computer Forensics" – Kevin Mandia, Chris Prosise.
2. "Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes" – Albert Marcella, Robert Greenfield.

Reference Books:

1. "Computer Forensics and Cyber Crime: An Introduction" – Marjie T. Britz.
2. "Guide to Computer Forensics and Investigations" – Bill Nelson, Amelia Phillips, Christopher Steuart.

Web Links:

1. https://www.researchgate.net/publication/253393425_Digital_Forensics_and_Cyber_Crime
2. https://annamalaiuniversity.ac.in/studport/download/engg/it/resources/Cyber%20Forensics.pdf
3. https://mrcet.com/downloads/digital_notes/CSE/III%20Year/12082022/DIGITAL%20FORENSICS.pdf
4. https://www.geeksforgeeks.org/cyber-forensics
5. https://www.eccouncil.org/train-certify/computer-hacking-forensic-investigator-chfi/

Forensic Physics & Ballistics

Course Code: 2511FS43
Semester – II
Course Outcomes:

L	T	P	C
2	0	2	4

At the end of the course, students will be able to:

CO1: Understand the fundamental principles and scope of forensic physics and ballistics.
CO2: Identify and analyze various types of physical evidence related to forensic physics.
CO3: Comprehend the mechanics and classifications of firearms and ammunition.
CO4: Apply forensic techniques in the examination of ballistic evidence.
CO5: Interpret the legal frameworks and ethical considerations in forensic physics and ballistics.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	2	1	-	-	-	-	-	-
CO2	3	2	-	3	2	-	1	-	-	-	-
CO3	3	2	-	3	2	-	-	-	-	-	-
CO4	2	3	-	3	3	-	1	-	-	-	-
CO5	2	1	3	1	2	-	3	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	1	1
CO3	1	1
CO4	1	1
CO5	1	2

Unit-Wise Syllabus:

UNIT – I: Introduction to Forensic Physics and Ballistics

Introduction to Forensic Physics, Definition, Scope, and Significance in Forensic Science, Historical Developments. Fundamental Principles and Laws of Physics in Forensic Investigations. Firearms: Definition, Characteristics & Classification, History and Background of Firearms, Functional Assembly & Working Principle of Firearms, Characteristics & Working Mechanism of Standard: Rifled Firearms, Small Arms, Shot Guns & Non-Standard: Improvised, Country Made, Imitative Firearms, Classifications of Ammunition, Different Types of Ammunition & Their Types, Safety Aspects for Handling Firearms and Ammunition, Cartridge-Firing Mechanism.

Practice - Analysis of glass fracture patterns to determine the direction of force.

UNIT – II: Paint, Fibers, Glass, and Toolmarks

Paint, fibers, glass, and toolmarks as forensic evidence. Paint analysis - types, composition, pigment distribution, and chemical properties, using techniques like solubility tests, Py-GC etc. Glass analysis includes types (soda-lime, borosilicate, safety, laminated, tempered), fracture patterns (rib marks, hackle marks, cone and radial fractures), and forensic techniques (refractive index, density gradient, Becke-line, and specific gravity tests). Toolmark analysis - compression and striated marks, class vs. individual characteristics, and Restoration and Chemical Etching. Restoration of obliterated marks using etching, magnetic, and electrolytic methods.

Practice - Microscopic examination and comparison of soil samples from different locations.

Unit-III Types of Ballistics

Internal Ballistics: Ignition of propellants, shape and size of propellants, various factors affecting the internal ballistics: lock time, ignition time, barrel time, erosion, corrosion and gas cutting, equation of motion of projectile, Density of loading, Pressure, Heat problems, Vibration & jump, Measurement of strength of firearm, projectile velocity determination, theory of recoil, methods for measurement of recoil.

External Ballistics: principal of external ballistics: vacuum trajectory, Trajectory Formation & its computation, effect of air resistance on trajectory, Angle of Fall, Influence of Earth on Trajectory, base drag, yaw, shape of projectile and stability.

Terminal Ballistics: Effect of projectile on hitting the target: function of Bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, Influence of range Cavitation- Temporary and permanent cavities, Ricochet and its effects, stopping power.

Practice - Identification and comparison of tool marks on various substrates (Fired Bullets, Cartridge case, etc).

UNIT IV- Wound Ballistics and Gunshot Residues

Wound Ballistics: Threshold velocity for penetration of skin/flesh/bones, preparation of gel block, penetrative in gel block and other targets, nature of wounds of entry, exit, explosive wounds, evaluation of injuries caused due to shot-gun, rifle, handguns and country made firearms, methods of measurements of wound ballistics parameters, post-mortem and anti-mortem firearm injuries, differentiating between accidental and suicidal firing, determination. Time of firing. Gunshot Residues/ Powder Residues: GSR distribution, Location, source and collection of GSR, Reconstruction of sequence of events involved in a shooting case, analysis of GSR: spot test, chemical test, identification of shooter, Practical problems related with GSR detections.

Practice - Examination and comparison of firearm discharge residues using chemical tests.

Unit-V Forensic Engineering

Introduction to forensic engineering**,** Analysis of the Construction Materials, Sampling, Collection & Preservation of the Materials with Relevant Information Required for the Investigation, Determination of Adulterants by Physical, Chemical and Instrumental Methods, ISI/Code of Building Construction, Structural failures, static loads, dynamic loads, causes of structural collapse, Types of cement and their composition, determination of adulterants by physical, chemical and instrumental methods, examination of brick, analysis of Bitumen & road materials, analysis of cement mortar and cement concrete & stones, forensic examination of electrical appliances installations.

Practice - Trajectory reconstruction in shooting incidents using ballistic principles.

Textbooks:

1. Heard, B. J. (2008). *Handbook of firearms and ballistics: Examining and interpreting forensic evidence* (2nd ed.). Wiley.
2. Rathore, L. (2021). *Ballistic in forensic science*. Walnut Publication.

Reference Books:

1. Mann, R. W., & Goliath, J. R. (2019). *Forensic firearm examination*. Academic Press.
2. Heard, B. J. (2013). *Forensic ballistics in court: Interpretation and presentation of firearms evidence*. Wiley-Blackwell.

Web Links:

1. https://www.nist.gov/firearms-and-toolmarks
2. https://www.scribd.com/document/457481678/FORENSIC-BALLISTIC-FINAL
3. https://www.hilarispublisher.com/open-access/unveiling-the-mysteries-of-forensic-ballistics-solving-crimes-one-bullet-at-a-time-99959.html
4. https://link.springer.com/article/10.1007/s11042-022-14037-x
5. https://dfsl.maharashtra.gov.in/en/ballistics

Forensic Psychology & Criminology

Course Code: 2511FS44
Semester – II
Course Outcomes:

L	T	P	C
3	0	1	4

At the end of the course, students will be able to:

CO1: Understand the fundamental concepts of forensic psychology and criminology, including historical developments and ethical considerations.
CO2: Analyze criminal behavior through various biological, psychological, and sociological theories.
CO3: Apply psychological principles in criminal investigations, including offender profiling, lie detection, and eyewitness testimony evaluation.
CO4: Examine the role of forensic psychologists in legal proceedings, including expert testimony, jury psychology, and rehabilitation of offenders.
CO5: Evaluate contemporary issues in forensic psychology, such as cybercrime, terrorism psychology, and the impact of artificial intelligence in forensic investigations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	2	-	2	-	-	-	3	-	1
CO2	2	-	-	-	3	-	-	-	3	-	-
CO3	2	2	2	1	3	-	1	-	3	-	-
CO4	2	1	3	-	2	-	3	-	2	-	1
CO5	2	1	2	1	2	1	2	2	3	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	2
CO2	1	2
CO3	1	2
CO4	1	2
CO5	1	2

Unit-Wise Syllabus:

UNIT – I: Introduction to Forensic Psychology & Criminology

Definition and scope of forensic psychology, history and development, key contributors in forensic psychology and criminology, differences between forensic psychology and criminology, role of forensic psychologists in the criminal justice system, ethical considerations in forensic psychology, applications of forensic psychology in law enforcement, correctional psychology, victimology, forensic psychiatry, psychological autopsy, challenges in forensic psychology.

Practice - To differentiate between forensic psychology and criminology through case studies.

UNIT – II: Criminal Behaviour & Psychological Theories

Biological theories of crime, genetic and neurobiological factors, psychological theories of crime, psychodynamic approach, cognitive theories, behavioural theories, personality disorders and crime, psychopathy and sociopathy, sociological theories of crime, strain theory, labelling theory, social learning theory, anomie theory, role of family and childhood experiences in criminal behaviour, impact of peer pressure and media on crime, juvenile delinquency, serial killers and mass murderers, terrorism psychology, sexual offenders and paedophilia, mental illness and crime.

Practice - To explore the applications of forensic psychology in victimology and correctional settings.

UNIT – III: Crime Investigation & Psychological Assessment

Offender profiling, psychological autopsy, investigative psychology, crime scene analysis, geographic profiling, risk assessment tools, forensic interviewing techniques, interrogation methods, psychology of deception and lie detection, polygraph testing, cognitive load and statement analysis, victimology and victim profiling, post-crime behaviour, eyewitness memory and testimony, suggestibility and misinformation effect, false memories, repressed memories, impact of crime on victims, psychological support for victims, role of forensic psychologists in criminal investigations.

Practice - To understand offender profiling techniques through practical exercises.

UNIT – IV: Legal Psychology & Courtroom Dynamics

Competency evaluations, insanity defense and criminal responsibility, diminished capacity, forensic psychology in civil cases, child custody evaluations, role of forensic psychologists in court, expert witness testimony, cross-examination of psychological experts, jury selection and psychology, courtroom persuasion techniques, psychological factors influencing jurors, psychology of false confessions, wrongful convictions, rehabilitation and correctional psychology, criminal sentencing and psychological assessments, recidivism risk factors, effectiveness of rehabilitation programs.

Practice - To investigate the psychological effects of mass shootings, child abuse, and domestic violence.

UNIT – V: Contemporary Issues & Applications in Forensic Psychology

Cybercrime psychology, cyberbullying and online harassment, psychological aspects of hacking and identity theft, radicalization and terrorism psychology, psychological impact of prison and solitary confinement, forensic neuropsychology, brain imaging in forensic psychology, artificial intelligence in criminal behaviour prediction, psychology of organized crime, drug abuse and criminal behaviour, forensic hypnosis, behavioural analysis in counterterrorism, psychological aspects of mass shootings, child abuse and neglect, domestic violence psychology, stalking and harassment psychology, emerging trends in forensic psychology research.

Practice - To study the role of forensic psychologists in criminal investigations through case analysis

Textbooks:

1. Bartol, C. R., & Bartol, A. M. (2018). *Introduction to forensic psychology: Research and application* (5th ed.). SAGE Publications.
2. Howitt, D. (2018). *Introduction to forensic and criminal psychology* (6th ed.). Pearson Education.

Reference Books:

1. Brown, J. M., & Campbell, E. A. (2010). *The Cambridge handbook of forensic psychology*. Cambridge University Press.
2. American Psychological Association. (2015). *APA handbook of forensic psychology* (Vols. 1-2). APA Books.

Web Links:

1. American Psychological Association - Forensic Psychology
2. International Association for Correctional and Forensic Psychology
3. https://www.britsoccrim.org/
4. https://www.asc41.com/
5. https://www.ojp.gov/ncjrs/new-ojp-resources

Forensic Toxicology & Pharmacology

Course Code: 2511FS45
Semester – II
Course Outcomes:

L	T	P	C
3	0	1	4

At the end of the course, students will be able to:

CO1: Understand the fundamental concepts of forensic psychology and criminology, including historical developments and ethical considerations.
CO2: Analyze criminal behavior through various biological, psychological, and sociological theories.
CO3: Apply psychological principles in criminal investigations, including offender profiling, lie detection, and eyewitness testimony evaluation.
CO4: Examine the role of forensic psychologists in legal proceedings, including expert testimony, jury psychology, and rehabilitation of offenders.
CO5: Evaluate contemporary issues in forensic psychology, such as cybercrime, terrorism psychology, and the impact of artificial intelligence in forensic investigations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	3	-	2	-	2	-	3	-	1
CO2	1	2	1	-	3	-	1	-	2	-	1
CO3	2	1	2	-	3	-	1	-	3	-	1
CO4	2	2	3	-	2	-	3	-	2	-	1
CO5	2	2	2	-	3	2	2	2	2	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	1	1
CO3	1	1
CO4	1	1
CO5	1	1

Unit-Wise Syllabus:

UNIT – I: Concepts of Toxicology

Introduction and concepts of Forensic Toxicology. Introduction to Poisons, forms of poisons, classification and methods of administration of poison. Mode of action of poison, Diagnosis and management of poisoning cases. Factors affecting the effect of poison and medico-legal aspects in poisoning cases Law relating to poisons. Toxicological Exhibits in Fatal and Survival Cases, their Preservation, Treatment in Cases of Poisoning, Analysis Report. Introduction to pesticides.

Practice - Systematic extraction and detection of poisons and drugs from visceral samples by various suitable chemical and instrumental techniques

UNIT – II: Principles of Toxicology

Routes of administration of poisons- Inhalation, Ingestion, Injection, topical. Mode of action of poisons, Clinical features in poisoning. Elimination of poisons- Urinary excretion, fecal excretion and other routes of elimination.

Study of dose-response relationships, molecular mechanisms of toxicant action, organ-specific toxicity (liver, kidney, nervous system), modulation of toxic effects, and toxicodynamics of poisons and drugs. Introduction to antidotes, types of antidotes.

Practice - Detection of metallic poisons from viscera samples and food samples.

UNIT – III: Isolation and Extraction Techniques

Extraction of Non-Volatile Organic Poison, Stas-Otto, Ammonium Sulphate Method, Acid Digestion Methods, Solid Phase Microextraction Techniques, Solvent Extraction Methods. Volatile Poisons: Industrial Solvent Acid and Basic Distillation. Toxic Cations: Dry Ashing and Wet Digestion Process. Toxic Anions: Dialysis Method, Supercritical Fluid Extraction of Toxic Substances, Headspace Analysis for Volatile Poisons.

Practice - Identification of vegetable poisons of Forensic interest.

UNIT – IV: Toxicological Extraction Methods

Extraction of volatile poisons: Industrial solvents, acid and basic distillation. Non-volatile poison extraction: Stas-Otto, ammonium sulfate, and solvent extraction techniques. Solid phase microextraction and accelerated solvent extraction. Toxic cations and anions: Dry ashing, wet digestion, and dialysis methods. Applications of modern extraction techniques in forensic toxicology.

Practice - Thin layer chromatography and Instrumental analysis for common drugs encountered.

UNIT – V: Forensic Pharmacology

Definitions, scope, and its importance in forensic science. Pharmacodynamics: Drug-receptor interactions, agonists, antagonists, and mechanisms of action. Pharmacokinetics: Absorption, distribution, metabolism, and excretion of drugs. Classification of Drugs. Mechanism of Drugs-Drugs of abuse: Stimulants, depressants, hallucinogens, and opioids. Prescription and over-the-counter drugs: Analgesics, sedatives, and antibiotics. Adverse Drug Reactions (ADRs).Therapeutic and Toxic Effects. Drugs & Cosmetics Act 1945 (Definition, Adulterated, Misbranded, Spurious Drugs and Cosmetics, Offenses and Penalties). Drug Receptor concept, types of receptors and mechanism of action, Agonism, Antagonism, Addiction, Synergism, Potentiation, Pharmacokinetic, various biological barriers, drug hypersensitivity.

Practice - Analysis of NSAID drugs by UV and TLC.

Textbooks:

1. Parikh C.K. (1972). Forensic Medicine and Toxicology. India, Medical Publications.
2. Modi, R. B. J. P. (2013). A textbook of medical jurisprudence and toxicology. Elsevier.

Reference Books:

1. Casarett, L J and Doul John ; Toxicology :The Basic Science of Poison, Macmillan Publ. Co. New York (1975).
2. Levine, B. (Ed.). (2003). Principles of forensic toxicology. Amer. Assoc. for Clinical Chemistry.

Web Links:

1. Swayam- https://onlinecourses.swayam2.ac.in/ini24_bt04/preview
2. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_pg/697
3. https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/forensic-toxicology
4. https://pmc.ncbi.nlm.nih.gov/articles/PMC4832912/?utm_
5. https://www.alliant.edu/blog/what-is-forensic-pharmacology

Forensic Medicine, Anthropology and Odontology

Course Code: 2511FS46

L	T	P	C
2	0	2	4

Semester - II

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand forensic medicine, its legal aspects, and its role in crime investigation.
CO2: Analyze thanatology, postmortem changes, and forensic entomology.
CO3: Perform medico-legal autopsy and interpret postmortem findings.
CO4: Identify human remains using forensic anthropology techniques.
CO5: Apply forensic odontology for personal identification and bite mark analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	3	1	2	-	2	-	1	-	1
CO2	2	3	1	2	3	-	1	-	1	2	1
CO3	2	3	3	2	2	-	2	-	1	2	1
CO4	2	2	1	3	2	-	1	-	1	2	1
CO5	2	2	1	3	2	-	1	-	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	1	1
CO3	1	1
CO4	1	1
CO5	1	1

Unit-Wise Syllabus:

UNIT – I: Forensic Medicine - Legal and Ethical Aspects

Forensic Medicine – Definition, Scope & Evolution – Historical development, Modern trends, Role in crime investigation. Medical Jurisprudence & Legal Framework - Medical Council of India & National Medical Commission (NMC). Ethical & Legal Aspects – Medical Negligence, Consent, Medical Ethics in Practice. Medico-Legal Documentation – Summons, Subpoena, Medical Evidence, Death Certificate. Inquest & Legal Systems – Magistrate Inquest, Police Inquest, Coroner's Inquest. Legal Responsibilities of Medical Practitioners – Conduct in Court, Expert Testimony. Advanced Concepts in Forensic Pathology – Post-mortem findings in torture cases, Medical Malpractice, Euthanasia, & Assisted Suicide.

Practice – Report writing on Autopsy visit.

UNIT – II: Thanatology & Postmortem Changes

Concept of Death in Forensic Science - Thanatology – Definition & Scope. Classification of Death. Modes & Manner of Death. Postmortem Changes & Estimation of PMI (Post-Mortem Interval) - Immediate, Early Changes, & Late Changes after Death. Environmental Influences on Decomposition. Cadaveric Spasm & Taphonomy in Forensic Investigations. Forensic Entomology & Time Since Death Estimation. Entomological Evidence & Insect Succession in Decomposing Bodies. Application of Arthropods in Criminal Investigations – Role of Blowflies, Beetles, and Mites. Advancements in Forensic Entomology – DNA Extraction from Maggots, Climate Impact on Insect Activity.

Practice - Human skeleton Identification.

UNIT – III: Medico-legal Aspects of Autopsy & Virtopsy

Autopsy Principles & Types - Medico-Legal Autopsy vs. Clinical Autopsy. Objectives & Protocols of Autopsy. Postmortem Reporting & Chain of Custody – External & Internal Examination. Autopsy Techniques & Their Applications - Virchow, Rokitansky, Ghon, Letulle Techniques. Fetal Autopsy & Its Relevance in Infant Mortality Cases. Advanced Techniques in Postmortem Analysis - Imaging Autopsy (Virtopsy) – Role of MRI, CT, and X-ray in Forensic Medicine. Exhumation & Its Legal Importance. Purpose, Procedure & Challenges in Body Exhumation. Postmortem Changes in Buried & Submerged Bodies. Examination of Decomposed and mutilated bodies.

Practice - Age & Sex Determination from Skeletal Remains.

UNIT – IV: Forensic Anthropology & Osteology

Introduction to Anthropology & Osteology– Identification from Skeletal Remains – Human vs. Animal Bone Differentiation. Sex Determination from Bones – Pelvis, Skull, Femur, Mandible. Age Estimation Methods – Cranial Sutures, Epiphyseal Union, Dental Eruption. Stature Reconstruction – Long Bone Measurements & Regression Formulae. Facial Reconstruction &

Superimposition Techniques - Two-Dimensional & Three-Dimensional Facial Reconstruction. Craniofacial Superimposition – Manual & Digital Methods. Skeletal Trauma Analysis in Forensic Cases - Sharp Force Trauma, Blunt Force Trauma, Gunshot Wounds on Bones. Interpretation of Peri-mortem & Post-mortem Bone Fractures. Role of Anthropologist at Crime Scene.

Practice - Stature Estimation from Long Bones.

UNIT – V: Forensic Odontology - Identification & Analysis

Introduction, Scope and Significance of Forensic Odontology. Dental Anatomy & Its Forensic Applications. Development & Architecture of Teeth – Enamel, Dentin, Pulp. Dental Charting & Dental Records – Role in Mass Disaster Identification. Forensic Dental Identification Techniques - Sex & Race Determination from Dental Features. Age Estimation from Teeth – Gustafson's Method, Cementum Annulation. Bite Mark Analysis in Criminal Investigations - Classification of Bite Marks – Human, Animal, Self-inflicted. Bite Mark Collection & Preservation Techniques – Photographic, 3D Imaging, Casts. Comparison & Matching Techniques – Digital Overlay, Computer-Assisted Methods.

Practice - Dental Identification & Bite Mark Analysis.

Textbooks:

1. Reddy, K. S. N. *The Essentials of Forensic Medicine & Toxicology*.
2. Principles and of Forensic Science and Toxicology by Rajesh Bardale.

Reference Books:

1. Saukko, P., & Knight, B. *Knight's Forensic Pathology*.
2. Gordon, I., & Shapiro, H. A. *Forensic Medicine: A Guide to Principles*.

Web Links:

1. https://nij.ojp.gov/topics/forensics/forensic-anthropology?utm
2. https://www.ada.org/resources/ada-library/oral-health-topics/forensic-dentistry-and-anthropology?utm
3. https://forensiccoe.org/forensic-anthropology/?utm
4. https://dofs-gbi.georgia.gov/document/document/forensic-biology-0/download
5. https://link.springer.com/book/10.1007/978-1-4684-0116-5?utm

Instrumentation and Analytical Techniques

Course Code: 2511FS47
Semester – II
Course Outcomes:

L	T	P	C
2	0	2	4

At the end of the course, students will be able to:

CO1: The fundamental principles and applications of different microscopy techniques, including optical and electron microscopy, for forensic analysis.
CO2: Demonstrate an understanding of chromatographic and hyphenated techniques for effective separation and identification of forensic samples.
CO3: Analyze spectroscopic and molecular techniques, including UV-Vis, IR, Raman, NMR, and mass spectrometry, for forensic sample characterization.
CO4: Apply elemental analysis techniques such as atomic spectroscopy, X-ray methods, and neutron activation analysis for forensic and material investigations.
CO5: Utilize biological and biochemical analytical techniques, including centrifugation and electrophoresis, for the examination of forensic biological evidence.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2	-	3	2	-	1	-	-	-	1
CO2	2	3	-	2	2	-	1	-	-	-	1
CO3	2	2	-	2	2	-	1	-	-	-	1
CO4	2	2	-	3	2	-	1	1	-	-	1
CO5	1	3	-	2	1	-	1	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	1	1
CO3	1	1
CO4	1	1
CO5	1	1

Unit-Wise Syllabus

UNIT - I: Microscopy and Optical Techniques

Fundamental principles of microscopy. Types, Principles and Instrumentation of Microscopes: Simple, Compound, Light, and Electron Microscopes. Specialized Microscopes: Comparison, Phase Contrast, Stereoscopic, Polarizing, Fluorescence, Infrared (IR), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM). Advanced Techniques: Confocal Laser Scanning Microscopy (CLSM), Atomic Force Microscopy (AFM), Fluorescence Lifetime Imaging Microscopy (FLIM), and Multiphoton Microscopy.

Practice - Examination of forensic samples using a comparison microscope.

UNIT - II: Chromatography & Hyphenated Techniques

Principle of Partition, Adsorption, Ion Exchange, Affinity, and Size Exclusion Chromatography. Principle, Instrumentation and Working: Gas Chromatography (GC), GC-MS, Tandem GC-MS/MS, Pyrolysis GC and Headspace GC. High-Performance Liquid Chromatography (HPLC), LC-MS, Tandem LC-MS/MS. Supercritical Fluid Chromatography (SFC). Advanced Separation Techniques: Ultra-Performance Liquid Chromatography (UPLC), Capillary Electrophoresis (CE), and Field Flow Fractionation (FFF).

Practice - Separation drugs using Thin Layer Chromatography (TLC).

UNIT - III: Spectroscopy & Molecular Analysis

Electromagnetic Spectrum and Radiation Properties. Spectroscopic Techniques - Instrumentation & Working: UV-Visible Spectroscopy, Infrared (IR) Spectroscopy, Fourier Transform IR (FT-IR), Raman Spectroscopy, and Fourier Transform Near-Infrared (FT-NIR) spectroscopy. Nuclear Magnetic Resonance (NMR) Spectroscopy: 1H-NMR, 13C-NMR, and Solid-State NMR. Mass Spectrometry (MS) Techniques: Time-of-Flight Mass Spectrometry (TOF-MS), Matrix-Assisted Laser Desorption/Ionization (MALDI-MS), and Electrospray Ionization (ESI-MS). Hyphenated Spectroscopic Techniques: ICP-MS (Inductively Coupled Plasma Mass Spectrometry), X-ray Photoelectron Spectroscopy (XPS), Laser-Induced Breakdown Spectroscopy (LIBS), Surface-Enhanced Raman Spectroscopy (SERS).

Practice - Identification of drug samples using UV-Visible Spectroscopy.

UNIT - IV: Elemental Analysis & Separation Techniques

Atomic Spectroscopy - Principle, Instrumentation and Working of Atomic Absorption Spectroscopy (AAS) and Atomic Emission Spectroscopy (AES). Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Neutron Activation Analysis (NAA) & X-Ray Diffraction (XRD). Energy-Dispersive X-ray Fluorescence (EDXRF). Glow Discharge Optical Emission Spectroscopy (GD-OES).

Practice - Identification of Drugs and Poison using HPLC.

UNIT - V: Biological & Biochemical Analytical Techniques

Introduction to pH, buffer systems, and pH meters. Physiological solutions and theories of precipitation, coagulation, sedimentation, and centrifugation. Definition, Principle, Types & Working of Centrifugation. Electrophoretic techniques: Zone Electrophoresis (ZE) - Paper Electrophoresis (PE), Gel Electrophoresis and (AGE, PAGE, SDS-PAGE), and cellulose acetate Electrophoresis. Moving Boundary Electrophoresis - Capillary Electrophoresis, Isotachophoresis, Isoelectric Focusing (IEF), Immuno-Electrophoresis and Pulsed-Field Gel Electrophoresis (PFGE).

Practice - DNA separation using Agarose Gel Electrophoresis.

Textbooks:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of Instrumental Analysis* (7th ed.). Cengage Learning.
2. Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. (1988). *Instrumental Methods of Analysis* (7th ed.). Wadsworth Publishing.

Reference Books:

1. Rouessac, F., & Rouessac, A. (2013). *Chemical Analysis: Modern Instrumentation Methods and Techniques* (2nd ed.). Wiley.
2. Hollas, J. M. (2004). *Modern Spectroscopy* (4th ed.). Wiley.

Web Links:

1. https://www.microscopyu.com
2. https://www.forensicsciencesimplified.org
3. https://www.sciencedirect.com/topics/chemistry/hyphenated-techniques
4. https://www.rsc.org
5. https://www.ncbi.nlm.nih.gov

Multimedia Forensics

Course Code: 2511FS48
Semester - II
Course Outcomes:

L	T	P	C
3	0	1	4

At the end of the course, students will be able to:

CO1: Analyze digital images, videos, and audio using forensic methodologies for investigation and authentication.
CO2: Detects and investigates forgery, tampering, and deep fake content using forensic analysis techniques.
CO3: Apply forensic techniques to extract, verify, and interpret multimedia metadata for evidential purposes.
CO4: Utilize forensic tools to enhance, restore, and validate multimedia evidence effectively.
CO5: Understand legal frameworks, ethical considerations, and the admissibility of multimedia evidence in forensic investigations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1	--	3	-	2	3	-	-	1
CO2	1	2	1	-	2	-	1	2	-	-	1
CO3	2	1	1	-	2	-	2	3	-	-	1
CO4	2	2	1	-	3	-	2	2	1	-	1
CO5	1	1	3	-	2	-	2	2	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	1
CO2	1	1
CO3	1	1
CO4	1	1
CO5	-	1

Unit-Wise Syllabus

UNIT – I: Introduction to Multimedia Forensics

Fundamentals of Multimedia Forensics: Definition, importance, and applications in law enforcement, journalism, and cybercrime investigations. Types of Multimedia Evidence: Digital images, videos, audio, and metadata. Basic Principles of Digital Imaging: Pixel representation, color models, and compression techniques (JPEG, MPEG). Metadata in Forensics: EXIF data, geotagging, timestamps, and device identification. Steganography & Anti-Forensic Techniques: Common steganographic methods, steganalysis techniques, and counter-steganography frameworks. Challenges in Multimedia Forensics: Format inconsistencies, data manipulation, and forensic data storage artifacts. Cryptographic and Blockchain-Based Evidence Verification: Use of cryptographic hashing (MD5, SHA-256) and blockchain in forensic evidence tracking.

Practice - Extract video metadata using FFmpeg to analyze codec, frame rate, and encoding details.

UNIT – II: Image Forensics

Image Authentication Techniques: Source camera identification, sensor noise analysis, and PRNU (Photo Response Non-Uniformity). Forgery Detection: Copy-move forgery, splicing, resampling, and compression artifacts. Advanced Forgery Detection: Multi-modal feature extraction, deep learning for copy-move detection, adversarial attacks in forgery detection. Steganalysis: Detecting hidden messages using statistical and deep learning techniques, GAN-based steganography detection. Image Enhancement and Recovery: Sharpening, denoising, contrast adjustments, and restoration of degraded images. Forensic Image Reconstruction: CNN-based super-resolution, hyperspectral image analysis, and forensic watermarking techniques. Tools for Image Forensics: Amped Authenticate, Ghiro, OpenCV, MATLAB, and AI-based forensic pipelines.

Practice - Detect frame duplication, insertion, and deletion using Amped FIVE or VideoCleaner.

UNIT – III: Video Forensics

Video Evidence Acquisition: Sources, formats, frame rates, encoding techniques, and codec-specific forensic analysis. Forgery & Deepfake Detection: Frame duplication, frame insertion/deletion, inter-frame inconsistencies, AI-based manipulation techniques, facial morphing, and adversarial learning for deepfake detection. Temporal & Motion Analysis: Optical flow analysis, motion vector inconsistency detection, and frame-wise CNN-based forgery identification. Forensic Video Enhancement: Stabilization, noise reduction, motion analysis, AI-driven super-resolution, and multi-frame restoration. Industry-Standard Video Forensic Tools: Amped FIVE, FFmpeg, VideoCleaner, Deepware Scanner, OpenFace, and forensic deep learning models.

Practice - Identify deep fake content using Deepware Scanner or FaceForensics++.

UNIT – IV: Audio Forensics

Fundamentals of Digital Audio: Sampling, bitrate, codecs, and compression techniques. Audio Authentication: Voice profiling, microphone forensics, and tampering detection. Tampering Detection & Audio Integrity Verification: Electrical network frequency (ENF) analysis, reverberation-based tampering detection, and machine learning-based anomaly detection.

Noise Reduction and Speech Enhancement: Spectral analysis, speech enhancement using AI, and background noise removal. Deepfake Audio Detection & Speaker Profiling: GAN-based voice synthesis, forensic countermeasures for AI-generated audio, speaker identification, and forensic linguistics. Forensic Audio Enhancement & Voice Cloning Detection: AI-based spectral analysis and forensic speaker verification. Audio Forensics Tools: Adobe Audition, Praat, GoldWave, WaveSurfer, and deep learning-based forensic speech models.

Practice - Perform motion and optical flow analysis to detect inter-frame inconsistencies.

UNIT – V: Legal and Ethical Aspects of Multimedia Forensics

Legal Admissibility of Multimedia Evidence: Chain of custody, authenticity verification, and digital rights management (DRM). Cyber Laws & Regulatory Frameworks: IT Act 2000 (Digital India Act 2023), GDPR, copyright laws, ISO/IEC 27037, and NIST standards in digital forensics. Ethical Issues in Multimedia Forensics: Privacy concerns, ethical hacking, consent-based investigations, impact of manipulated media, and bias in forensic AI models. Case Studies in Multimedia Forensics: High-profile digital forgery cases, fake news detection, forensic applications in cybercrime investigations, large-scale misinformation campaigns, and forensic analysis of terrorist propaganda videos. Future Trends in Multimedia Forensics: AI-driven forensic automation, quantum forensics, and interdisciplinary forensic intelligence.

Practice - Generate a forensic report summarizing video forgery detection and deepfake analysis.

Textbooks:

1. Hany Farid, *Photo Forensics*, MIT Press, ISBN: 978-0262038936
2. Zeno Geradts & Katrin Franke, *Multimedia Forensics and Security*, Springer, ISBN: 978-3030276176

Reference Books:

1. Husrev Taha Sencar, *Digital Image Forensics: There is More to a Picture than Meets the Eye*, Springer, ISBN: 978-3642123363
2. Alan C. Bovik, *Handbook of Image and Video Processing*, Academic Press, ISBN: 978-0128119055

Web Links:

1. https://www.nist.gov/itl/iad/multimedia-forensics
2. https://deepware.ai/
3. https://detectdeepfakes.mit.edu/
4. https://29a.ch/photo-forensics/
5. https://scispace.com/pdf/digital-forensic-challenges-in-internet-of-things-iot-1zscj46w.pdf

Minor Stream Courses (MSC): 5 Specializations

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
MSC 1: Forensic Biology & DNA Fingerprinting											
2511FS01	III	Advanced Forensic Biology and Serology	AC	2	2	1	4	50	50	100	-
2511FS02		Wildlife Forensics & Entomology	AC	3	1	1	4	50	50	100	-
2511FS03		Advanced DNA Profiling	AC	2	2	1	4	50	50	100	-
2511FS04		Advanced Forensic Genetics & Bioinformatics	AC	3	1	1	4	50	50	100	-
2511FS05		Forensic Microbiology & Biotechnology	AC	2	2	1	4	50	50	100	-
2511FS06		Advanced Biochemistry and Human Physiology	AC	3	1	1	4	50	50	100	-
Total				**15**		**9**	**24**				

Minor Stream: 5 Specializations

MSC 1: Forensic Biology & DNA Fingerprinting

Advanced Forensic Biology and Serology

Course Code: 2511FS01

L	T	P	C
2	0	2	4

Semester – III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand Cellular Organization and Signaling Mechanisms – Protein sorting, vesicular transport, and key cell signaling pathways in normal and disease conditions.
CO2: Analyze Cell Cycle Regulation and Disease Mechanisms –Molecular regulation of the cell cycle, cytoskeletal dynamics, and their role in cancer and cell death.
CO3: Apply Advanced Immunological Techniques – Immunoglobulin function, antigen processing, hybridoma technology, and immune dysfunctions.
CO4: Utilize Forensic Serological and Blood Analysis Techniques – Perform serological assays, interpret antigen-antibody interactions, and analyze bloodstain patterns for forensic applications.
CO5: Explore Forensic Microbiology and Bioterrorism Investigations – Identify microbial agents of forensic importance, understand microbial genetics, and assess bioterrorism threats and biosafety measures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	2	2	-	1	-	1	-	1
CO2	2	1	-	2	3	-	1	-	-	-	1
CO3	1	2	-	3	2	1	1	-	-	-	1
CO4	2	3	1	3	3	-	2	-	1	-	1
CO5	2	2	-	2	2	1	1	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	2
CO4	3	3
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Cellular Organization and Signaling Mechanisms

Fundamentals of protein sorting and transport mechanisms- sorting signals, types of transport, and organelle-specific protein sorting (nucleus, ER, Golgi apparatus, mitochondria, chloroplast, peroxisomes, lysosomes). Vesicular transport and diseases associated with impaired transport processes. Cell signaling and regulatory pathways, cellular communication, receptor mechanisms (GPCRs, RTKs, cytokine receptors, NRTKs, enzyme-linked receptors), Roles in sensory functions - Vision, smell, and taste. Nitric oxide signaling, toxin mechanisms, developmental pathway signaling (Wnt, Notch, Hedgehog, NF-κB), plant signaling (auxin, ethylene, phytochromes), and circadian rhythm signaling in humans, Drosophila, and cyanobacteria.

Practice - To observe cell structure and identify basic organelles.

UNIT – II: Cell Cycle, Structural Dynamics, and Disease Mechanisms

Cell cycle regulation - mitosis, meiosis, Biochemical analysis of cell cycle control in mammalian cells. Checkpoint mechanisms, Role of cyclins and Cdks in cell cycle progression. Cytoskeletal elements, their structure, self-assembly, and dynamic properties. Cell death pathways, cancer progression, and their implications in disease. Cell culture techniques and assays. Applications in advanced cellular research.

Practice - To identify different stages of mitosis in plant cells.

UNIT – III: Advanced Immunology

Immunoglobulins & B-Cell Activation and differentiation. Monoclonal and Polyclonal Antibodies: Production and applications. Hybridoma Technology: Principles, methods, and applications. Antigens - Types of antigens, Antigen processing and presentation, Endogenous and exogenous pathways of antigen presentation. Major Histocompatibility Complex (MHC) & T-Cell Receptors - Structure and function. HLA Typing and its significance in immune response. Structure and function of T-cell receptors. Cytokines & Immune Responses - Role of cytokines

in immune regulation, Cell-mediated cytotoxic responses. Immune System Dysfunctions - Hypersensitivity reactions. Autoimmune diseases. Immunodeficiency disorders.

Practice - To determine ABO and Rh blood groups using antigen-antibody reactions.

UNIT – IV: Advanced Forensic Serological Techniques and Blood Physiology

Primary Binding Assays in Serology - Antigen-Antibody Interactions: Principles and significance. Precipitation Reactions, Agglutination Reactions, and Complement Fixation Test. Secondary Binding Assays in Serology - Enzyme-Linked Immunosorbent Assay (ELISA), Radioimmunoassay (RIA), Western Blotting. Instrumental Techniques in Forensic Serology - Fluorescence-Based Assays, Flow Cytometry. Bloodstain Pattern Analysis (BPA) - Introduction to Bloodstain Pattern Analysis (BPA), Principles of Bloodstain Formation, Classification of Bloodstains, Interpretation of Bloodstain Patterns, Documentation, Analysis, Significance, Limitations and Challenges in BPA.

Practice - Analysis of blood spatter pattern.

UNIT – V: Forensic Microbiology and Bioterrorism Investigations

Definition and scope of forensic microbiology. Classification of microorganisms: *Bacteria, viruses, fungi, protozoa.* Applications of microbiology in forensic investigations. Bacterial Structure and Function: Gram-positive vs. Gram-negative bacteria. Bacterial Growth and Reproduction: Growth curve and factors affecting microbial proliferation. Virology: Structure, classification, and viral replication. Microbial Genetics: Horizontal gene transfer: Transformation, transduction, conjugation. Role of plasmids and antibiotic resistance in forensic microbiology. Isolation, Cultivation, and Identification of Microbes, Microbial Diseases and Their Forensic Significance. Forensically Important Microbes - Bacteria: *Bacillus anthracis, Yersinia pestis, Francisella tularensis, Brucella spp., Burkholderia pseudomallei, Clostridium botulinum, Listeria monocytogenes.* Fungi: *Opportunistic mycoses, Chytridiomycota, Zygomycota, Aspergillus fumigatus, Microsporidium, Pneumocystis jirovecii, Aspergillus flavus, Candida sp.*. Bioterrorism and Biological Warfare Agents. Biosafety, Biosecurity, and Epidemiological Investigation.

Practice - To differentiate bacteria from curd using Gram staining.

Textbooks:

1. Lehninger, Nelson and Cox, Principles of Biochemistry, 7th Edition, Freeman, W. H. & Company, 2017.
2. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level, Wiley, 5th Edition. 2016.

Reference Books:

1. Forensic DNA Evidence Interpretation – John S. Buckleton, Christopher M. Triggs & Simon J. Walsh.
2. Fundamentals of Forensic DNA Typing – John M. Butler.

Web Links:

1. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/downloads/Introduction_To_Biochemistry.pdf?
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7150155/
3. https://www.kew.org/science/our-science/departments/forensic-botany
4. https://www.ars.usda.gov/northeast-area/higher-education-and-human-resources/poisonous-plant-research/
5. https://dbtindia.gov.in/

Wildlife Forensics & Entomology

Course Code: 2511FS02
Semester – III
Course Outcomes:

L	T	P	C
3	0	1	4

At the end of the course, students will be able to:

CO1: Understand the fundamentals of wildlife forensics and the legal frameworks governing wildlife crime at national and international levels.
CO2: Identify different types of wildlife crimes and analyze evidence collection methods in wildlife crime scene investigations.
CO3: Apply morphological and genetic techniques for species identification in wildlife forensic cases.
CO4: Utilize forensic entomology techniques to estimate post-mortem intervals and analyze insect succession in forensic cases.
CO5: Examine case studies, challenges, and emerging technologies in wildlife and forensic entomology investigations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	2	1	2	1	2	-	1	3	1
CO2	2	3	1	2	3	-	1	-	1	2	1
CO3	2	2	1	3	3	-	1	-	1	3	1
CO4	2	3	1	2	3	-	1	-	1	2	1
CO5	2	1	1	1	2	-	1	-	1	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	3
CO2	3	2
CO3	2	2
CO4	2	2
CO5	3	2

Unit-Wise Syllabus:

UNIT – I: Introduction to Wildlife Forensics

Fundamentals of Wildlife Forensics, Wildlife Crime and Conservation Laws: National & International Laws (Wildlife Protection Act, CITES, IUCN). Types of Wildlife Crimes: Poaching, Illegal Trade, Habitat Destruction, and Human-Wildlife Conflict. Wildlife Crime Scene Investigation: Evidence Collection, Chain of Custody, and Preservation of Biological and Non-Biological Evidence. Wildlife Trade Monitoring and Legal Aspects: TRAFFIC, INTERPOL, and Enforcement Agencies.

Practice - Identification of Wildlife Hair, Feathers, and Bones Using Morphological Features.

UNIT – II: Wildlife Identification and Genetic Analysis

Morphological Identification of Species: Hair, Feathers, Scales, Bones, Claws, and Skulls. Determination of Time of Death in Wildlife Cases. Sex Determination from Bones Using Morphological and Molecular Techniques. Identification of Teeth, Claws, Ivory, Horns, Antlers, Fur, Skin, Bite Marks, and Pugmarks. Wildlife Blood, Excreta, and Bone Identification Using Biochemical and Immunological Methods. DNA-Based Techniques in Wildlife Forensics: DNA Barcoding, STR Profiling, and Next-Generation Sequencing (NGS). Wildlife Population Genetics and Species Conservation.

Practice - DNA Extraction and Analysis for Wildlife Species Identification.

UNIT – III: Forensic Entomology

Introduction to Forensic Entomology: Definition, History, and Scope. Insects in Crime Investigation: Role of Insects in Determining Post-Mortem Interval (PMI). Types of Forensically Important Insects: Blowflies, Flesh Flies, Beetles, and Moths. Stages of Decomposition and Insect Succession. Collection and Preservation of Entomological Evidence.

Practice - Analysis of Blood and Excreta Samples for Species Determination.

UNIT – IV: Advanced Techniques in Forensic Entomology

Advanced techniques for Insect Development and PMI Estimation - Growth rate studies, degree-day models, and molecular markers for age determination. DNA-Based Identification of Insects: Mitochondrial DNA analysis, COI gene sequencing, and microsatellite markers. Microbiome and Insect-Gut Analysis. Role of insect-associated bacteria in decomposition and forensic analysis. Chemical Analysis of Insect Evidence: GC-MS and LC-MS techniques for detecting toxins, drugs, and volatile organic compounds in insect remains. Environmental and Climatic Effects on Insect Succession - Impact of temperature, humidity, and habitat variation on forensic entomological findings.

Practice - Collection and Preservation of Forensically Important Insects.

UNIT – V: Case Studies, Challenges, and Emerging Trends

Case Studies in Wildlife Crime and Entomology - Based Investigations. Challenges in Wildlife Forensics: Sample Degradation, Species Authentication, and Trafficking Routes. Emerging Technologies in Wildlife and Insect Forensics: Remote Sensing, AI, and Geospatial Analysis. Legal and Ethical Considerations in Wildlife and Entomology Cases.

Practice - Analysis of life cycle of blow flies.

Textbooks:

1. Cooper, J. E., & Cooper, M. E. (2013). *Introduction to Veterinary and Comparative Forensic Medicine.* Blackwell Publishing.
2. Huffman, J. E., & Wallace, J. R. (2019). *Forensic Entomology: The Utility of Arthropods in Legal Investigations.* CRC Press.

Reference Books:

1. Alves, R. R. N., & Albuquerque, U. P. (2017). *Ethnozoology: Animals in Our Lives.* Academic Press.
2. Miller, L. S., & Massey, P. J. (2020). *Crime Scene Investigation: Forensic Evidence Collection Methods.* CRC Press.

Web Links:

1. https://www.traffic.org
2. https://www.cites.org
3. https://www.wccb.gov.in
4. https://www.forensicentomology.com
5. https://www.isfg.org

Advanced DNA Profiling

L	T	P	C
2	0	2	4

Course Code: 2511FS03
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: The molecular basis of genetic information and DNA structure-function relationships.
CO2: Analyze the history, applications, and legal considerations of DNA profiling in forensic investigations.
CO3: Genetic manipulation techniques, including DNA isolation, cloning, and hybridization methods.
CO4: Apply advanced forensic DNA analysis methodologies, including STR, SNP, Y-STR, and mitochondrial DNA analysis.
CO5: Evaluate emerging DNA profiling technologies, including Next-Generation Sequencing (NGS) and forensic databases.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	2	2	-	1	-	-	-	1
CO2	2	2	3	2	2	-	2	-	-	-	1
CO3	2	3	-	3	2	1	1	-	-	-	1
CO4	2	2	1	3	3	1	2	-	-	-	1
CO5	1	2	1	2	2	2	1	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	3
CO3	3	-
CO4	2	2
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Molecular Basis of Genetic Information

Overview of molecules involved in genetic information flow. Double helical structure of DNA, alternate DNA forms. DNA denaturation and renaturation, DNA binding proteins. Factors affecting DNA stability. Types and structure of RNA, RNA-DNA hybrid helices. DNA repair mechanisms. Direct and indirect evidence for DNA and RNA as genetic material. Chemical nature of DNA and RNA. DNA replication in prokaryotes and eukaryotes. Genetic code: degeneracy and universality. Transcription and translation machinery.Structure of the human genome and its diversity. Mitochondrial DNA (mt-DNA), Y-chromosomes, and human migration. Concept of gene: conventional and modern views. Gene structure: split genes, pseudogenes, non-coding genes, overlapping genes, multiple gene families.

Practice - Extraction of DNA from biological samples.

UNIT – II: DNA Profiling and Legal Considerations

History of DNA profiling. Applications in forensic cases: paternity disputes, missing persons, immigration, wildlife, and agriculture. Legal perspectives: admissibility of DNA evidence, procedural and ethical concerns. Status of DNA profiling in India and abroad. Limitations and challenges in forensic DNA profiling.

Practice - Gel electrophoresis techniques.

UNIT – III: Genetic Manipulation and Analytical Techniques

Genetic manipulation techniques: restriction enzymes, molecular cloning procedures. Isolation of nucleic acids: cDNA and genomic library construction. Plasmid DNA preparation, sub-cloning techniques. Colony hybridization, nick translation, oligonucleotide probes. Gene expression analysis. Nucleic acid hybridization techniques. DNA sequencing methodologies. Electrophoresis: gel and capillary electrophoresis (principles, instrumentation, and applications). Capillary electro chromatography in forensic DNA analysis.

Practice - Estimation of DNA and RNA by UV absorption method and determination of purity of nucleic acids.

UNIT – IV: Advanced Forensic DNA Analysis

RFLP and PCR-based DNA typing. STR genotyping: interpretation of results. Mini-STRs, VNTRs, SNPs, and their forensic applications. Mitochondrial DNA analysis in forensic cases. Forensic significance of Y-STR analysis. Non-human DNA analysis in forensic investigations. Allele frequency determination and match probability estimation. DNA databases: CODIS, BOLD, HapMap, STRBase. Quality control, certification, and accreditation standards. Factors affecting forensic DNA analysis accuracy.

Practice - DNA database search and comparison using software tools.

UNIT – V: Emerging Trends in DNA Profiling

Next-Generation Sequencing (NGS): principles, instrumentation, applications. DNA sequencing techniques and forensic applications. Predicting physical characteristics (eye, hair, skin color) using DNA. Molecular autopsy and forensic pathology. Population genetics in forensic DNA analysis. Advanced forensic DNA databases and their role in criminal investigations.

Practice - Forensic case study analysis using population genetics.

Textbooks:

1. Butler, J.M. (2015). *Advanced Topics in Forensic DNA Typing: Interpretation*. Elsevier.
2. Goodwin, W., Linacre, A., & Hadi, S. (2016). *An Introduction to Forensic Genetics*. Wiley.

Reference Books:

1. Gill, P. (2014). *Misleading DNA Evidence: Reasons for Miscarriages of Justice*. Elsevier.
2. Strachan, T., & Read, A.P. (2018). *Human Molecular Genetics*. Garland Science.

Web Links:

1. FBI CODIS DNA Database
2. National Institute of Justice - Forensic DNA
3. International Society for Forensic Genetics (ISFG)
4. STRBase - NIST DNA Database
5. BOLD Systems - Barcode of Life Database

Advanced Forensic Genetics & Bioinformatics

L	T	P	C
3	0	1	4

Course Code: 2511FS04
Semester - III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand fundamental concepts of human genetics and Mendelian inheritance.
CO2: Analyze population genetics principles, including Hardy-Weinberg equilibrium and forensic applications.
CO3: Utilize bioinformatics tools and databases for genetic analysis in forensic science.
CO4: Apply statistical and computational methods for DNA profiling and forensic genomics.
CO5: Explore advanced molecular techniques, including forensic proteomics and serogenetic markers. Explore Advanced Molecular Techniques in Forensic Genetics.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	2	2	-	1	-	-	-	1
CO2	2	1	-	2	3	-	1	-	-	-	1
CO3	2	2	-	3	2	1	1	-	-	-	1
CO4	2	2	-	3	3	1	2	-	-	-	1
CO5	2	1	-	2	2	2	1	-	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	1
CO4	2	2
CO5	3	2

Unit-Wise Syllabus:

UNIT – I: Principles of Human Genetics & Chromosomal Disorders

Mendelian Laws of Inheritance – Monohybrid and Dihybrid Crosses, Law of Segregation & Independent Assortment. Gene Interactions & Non-Mendelian Inheritance – Supplementary & Complementary Genes (Comb patterns in fowls, Flower color in sweet peas). Epistasis (Inhibitory and colored genes in fowls).cMultiple Alleles and Blood Group Antigens. Classical Experiments in Genetics – Hershey & Chase, Avery, McLeod, and McCarty. Chromosome Structure & Organization – Centrosome, Telomere, Heterochromatin, Polytene & Lampbrush Chromosomes. Sex Determination Mechanisms – XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in plants and animals. Chromosomal Disorders & Genetic Diseases – Hemoglobinopathies (Sickle Cell, Thalassemia). Color Blindness, Hemophilia. Disorders of Coagulation & Non - Disjunction Events.

Practice - Sequence retrieval and analysis using NCBI, GenBank, and EMBL.

UNIT – II: Forensic and Evolutionary Perspectives of Genetic Diversity

Human Genetic Variations & Polymorphisms. Hardy-Weinberg Equilibrium & Its Applications in Population Genetics. Mutation – Types, Causes & Impact on Genetic Diversity. Relevance of Population Genetics in Forensics. Linkage disequilibrium and phylogenetic tools. Paternity/maternity and sibship indices. Genetic genealogy in forensic investigations. Allele Frequency & Genotype Frequency Calculation. Measures of Genetic Variation – Heterozygosity, Linkage Disequilibrium. Horizontal Gene Transfer in Microorganisms: Transformation, Transduction, Conjugation. Plasmids & Antibiotic Resistance Genes. Evolutionary Genetics & Genetic Drift in Populations. Pedigree Analysis & Genetic Disorders.

Practice - BLAST and FASTA search for DNA sequence similarity.

UNIT - III: Forensic Genomics & Statistical DNA Analysis

DNA Microarray Technology & Gene Prediction. Statistical Evaluation of DNA Profiles - Hardy-Weinberg Equilibrium. Bayesian Probability & Likelihood Ratio in DNA Matching. Paternity Index, Sibling Index & Probability of Match Calculations. Human Genome Project & Its Forensic Implications. Ethical, Legal & Social Issues in DNA Data banking.S

Practice - Hardy-Weinberg equilibrium calculations using sample population data.

UNIT - IV: Bioinformatics & Computational Genetics in Forensic Science

Introduction, Nature, Scope, Branches of Bioinformatics & Its Applications in Forensics. Biological Databases in Bioinformatics: Sequence databases and structure databases. Overview of major databases: NCBI, GenBank, DDBJ, EMBL (Genomic databases), UNI-PROT, PROSITE (Protein databases), RCSB-PDB, PIR-PSD (Structure databases), OMIM, PubMed (Literature databases). Bioinformatics tools: BLAST and FASTA. Pairwise sequence alignment: Global and local alignment. Multiple sequence alignment (MSA): Clustal W, Clustal X.

Sequence and Structure Visualization Tools - ORF Finder, Swiss PDB Viewer, RasMol, Cn3D, PyMOL.

Practice - Estimation of allele and genotype frequencies from provided datasets.

UNIT - V: Forensic Proteomics & Serogenetics

Introduction to Forensic Proteomics & Serology: Definition, scope, significance, and historical evolution. Protein Profiling in Forensic Science: Erythrocyte isoenzymes (PGM, GLO-I, ESD, EAP, AK, ADA), hemoglobin polymorphism, and HLA typing. Serogenetic Markers & Their Forensic Applications: Role in individualization, paternity disputes, and forensic casework. Proteomic Techniques in Forensic Science: Mass spectrometry-based protein analysis (MALDI-TOF, LC-MS), forensic proteomic databases, and data analysis.

Practice - Protein extraction and SDS-PAGE analysis.

Textbooks:

1. Hartl, D. L., & Clark, A. G. (2007). *Principles of Population Genetics*. Sinauer Associates.
2. Strachan, T., & Read, A. P. (2019). *Human Molecular Genetics*. Garland Science.

Reference Books:

1. Primrose, S. B., & Twyman, R. M. (2013). *Principles of Gene Manipulation and Genomics*. Wiley-Blackwell.
2. Goodwin, W., Linacre, A., & Hadi, S. (2011). *An Introduction to Forensic Genetics*. Wiley.

Web Links:

1. National Center for Biotechnology Information (NCBI)
2. DNA Learning Center – Cold Spring Harbor Laboratory
3. Forensic Genetics on PubMed
4. European Bioinformatics Institute (EMBL-EBI)
5. Genetics Home Reference – NIH

Advanced Forensic Microbiology & Biotechnology

Course Code: 2511FS05
Semester - III
Course Outcomes:

L	T	P	C
2	0	2	4

At the end of the course, students will be able to:

CO1: Understand microbial taxonomy, structure, function, and metabolism in forensic applications.
CO2: Apply microbial cultivation, isolation, and bioprocessing techniques in biotechnology.
CO3: Analyze microbial roles in forensics, including bioterrorism, food, and clinical investigations.
CO4: Explain rDNA technology, gene cloning, and genetic engineering in forensic biotechnology.
CO5: Evaluate genome editing, GMOs, biopharmaceuticals, and ethical aspects in forensic science.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	2	2	-	1	-	-	-	1
CO2	1	2	-	3	2	-	1	-	-	-	1
CO3	2	2	1	2	3	-	1	-	-	-	1
CO4	2	1	1	3	2	1	1	-	-	-	1
CO5	1	2	2	3	2	2	1	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	2
CO4	2	2
CO5	3	3

Unit-Wise Syllabus:

UNIT – I: Forensic Microbiology- I

Introduction to Microbiology: History, Scope, and Applications. Microbial Taxonomy & Classification: Prokaryotic & Eukaryotic Microorganisms (Bacteria, Fungi, Algae, Protozoa, Viruses). Microbial Structure & Function: Cell Wall, Membrane, Organelles, Flagella, Pili, and Spores. Cultivation & Maintenance of Microorganisms: Nutritional Categories, Isolation, Purification, and Preservation. Microbial Growth & Reproduction: Growth Curves, Generation Time, Batch & Continuous Cultures. Microbial Metabolism: Catabolic & Biosynthetic Pathways, Energy Production.

Practice - Isolation and Cultivation of Bacteria & Fungi from Forensic Samples.

UNIT - II: Microbial Cultivation and Bioprocessing Techniques

Culture & Isolation Techniques: Microbial Cultivation Methods: Selective, Differential, and Enrichment Media. Isolation and Preservation Techniques for Bacteria, Fungi, and Viruses. Cell Culture Techniques: Animal, Plant, and Microbial (E. coli, Saccharomyces cerevisiae, Influenza virus). Bioprocess & Bioengineering Techniques: Fermentation Technology: Batch, Fed-Batch, and Continuous Fermentation. Upstream & Downstream Processing in Biotechnology. Enzyme and Cell Immobilization Techniques. Production of Industrial Biochemicals, Biofuels (Biogas, Hydrogen, Biodiesel), and Microbial Insecticides.

Practice - Preparation of bacterial smears and Gram staining.

UNIT - III: Forensic Microbiology- II

Role of Microbiology in Forensic Investigations. Microbial Contaminants in Crime Scene Evidence. Detection of Bioterrorism Agents & Bioweapons. Water & Food Microbiology in Forensics: Bacterial Pollutants in Water, Coliform Testing, Sewage Composition & Disposal. Foodborne Pathogens, Spoilage, and Preservation Techniques. Medical & Clinical Microbiology in Forensics: Hospital-Acquired Infections, Antimicrobial Resistance, and Pathogen Identification.

Practice - Microbial Growth Curve Analysis & Generation Time Calculation.

UNIT - IV: Forensic Biotechnology - I

Introduction to Biotechnology: History, Scope, and Trends. Branches of Biotechnology: Animal, Environmental, Industrial, Medical, Microbial, Pharmaceutical, Nanobiotechnology, Plant & Agricultural Biotechnology. Gene Manipulation & Genetic Engineering: Concepts, tools, and applications. Introduction to Recombinant DNA Technology. Tools of rDNA Technology – Restriction Enzymes, Ligases, Polymerases. Vectors – Plasmids, Bacteriophages, Cosmids, BACs, YACs. Cloning Strategies. Gene Cloning & Expression - Transformation & Transfection Methods, Selection & Screening of Recombinants, Expression Systems – Bacteria, Yeast, Insect,

Mammalian Cells, Regulation of Gene Expression – Inducible & Constitutive Promoters, Gene Isolation & Purification Techniques.

Practice - Enzyme Immobilization Techniques in Biotechnology.

UNIT - V: Forensic Biotechnology - II

Genetically Modified Organisms (GMOs) – Overview, concepts, and significance. Transgenic Plants & Animals – Techniques & applications. Genome Editing Technologies – CRISPR-Cas9, TALENs, and Zinc Finger Nucleases. Biopharmaceuticals – Production and applications of recombinant insulin, growth hormones, and other therapeutic proteins. Forensic Biotechnology – Applications of genetic engineering in forensic science. Omics Technologies – Genomics, Proteomics, Transcriptomics, and Metabolomics in biotechnology. Ethical, Legal & Social Implications. Patents & Intellectual Property Rights (IPR) – Protection, commercialization, and regulatory aspects in biotechnology.

Practice - Detection of Waterborne & Foodborne Pathogens Using Microbial Techniques.

Textbooks:

1. *Microbiology: Concepts and Applications* – Pelczar, M. J., Chan, E. C. S., & Krieg, N. R.
2. *Brock Biology of Microorganisms* – Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A.

Reference Books:

1. *Handbook of Media for Clinical Microbiology* – Atlas, R. M., & Snyder, J. W.
2. *Medical Microbiology* – Murray, P. R., Rosenthal, K. S., & Pfaller, M. A.

Web Links:

1. https://www.ncbi.nlm.nih.gov/
2. https://www.cdc.gov/
3. https://www.fbi.gov/investigate/terrorism/wmd
4. https://pubmed.ncbi.nlm.nih.gov/
5. https://www.jptcp.com/index.php/jptcp/article/view/4569

Advanced Biochemistry and Human Physiology

Course Code: 2511FS06
Semester – III
Course Outcomes:

L	T	P	C
3	0	1	4

At the end of the course, students will be able to:

CO1: Analyze modern advancements in forensic medicine, including AI, blockchain, and digital pathology.
CO2: Evaluate medico-legal challenges and legal responsibilities of medical practitioners at national and international levels.
CO3: Apply advanced postmortem and thanatological techniques in forensic case investigations.
CO4: Implement modern forensic anthropology and skeletal analysis techniques for human identification.
CO5: Utilize emerging forensic odontology techniques for dental identification and bite mark analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	3	2	2	1	1	-	-	1
CO2	1	1	3	-	2	-	2	-	-	-	1
CO3	2	3	-	3	3	-	1	-	-	-	1
CO4	1	2	-	2	3	-	1	-	-	-	1
CO5	2	2	-	2	2	-	1	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	2
CO2	2	3
CO3	2	1
CO4	2	1
CO5	3	1

Unit-Wise Syllabus:

UNIT – I: Advanced Biochemistry

Basic principles of organic chemistry and chemical bonding, hybridization, molecular structures, acids, bases, pH, and buffering mechanisms using the Henderson-Hasselbalch equation. Biochemical reactions and interactions, functional groups, non-covalent interactions (hydrogen bonds, Van der Waals forces, electrostatic and hydrophobic interactions), Role of electrophiles and nucleophiles in biochemical reactions. Macromolecules and biomolecules includes carbohydrates (classification, isomerism, Fischer and Haworth projections, anomers, epimers, glycoconjugates), lipids (classification, properties, fatty acids, membrane lipids, steroids, and their functions), amino acids and proteins (classification, optical isomerism, chemical properties, acid-base properties, peptide bond formation, protein structure, Ramachandran plot, and protein denaturation).

Practice - Preparation of Laboratory Solutions and Buffers.

UNIT – II: Structural Biochemistry & Bioenergetics

Techniques for protein extraction and quantification - enzymatic lysis, homogenization, sonication, and bead mill shaking, protein assays - Biuret, Lowry, BCA, and Bradford. Protein precipitation and purification methods- salting-in, salting-out, dialysis, ultrafiltration, and centrifugation. Chromatographic Techniques, Electrophoretic Techniques, and Spectroscopy Methods. Bioenergetics and thermodynamics, Laws of thermodynamics, Gibbs free energy, standard free energy changes, and their relationship with equilibrium constants. ATP structure and function, coupled reactions, and high-energy compounds.

Practice - Separation of Amino acids using TLC.

UNIT – III: Metabolic Pathways & Energy Dynamics

Carbohydrate metabolism - glycolysis, gluconeogenesis, TCA cycle, glyoxylate cycle, amphibolic and anaplerotic reactions, the electron transport chain, oxidative phosphorylation, ATP production, Pentose phosphate pathway, glycogen metabolism, and photosynthesis (light and dark reactions, photophosphorylation, Calvin cycle, C4 and CAM pathways). Lipid metabolism - fatty acid oxidation (beta, alpha, and omega oxidation, ketone bodies), biosynthesis of fatty acids, triacylglycerols, cholesterol, and regulation of lipid metabolism. Amino acid and nucleic acid metabolism - amino acid catabolism (transamination, deamination, urea cycle, metabolic disorders - phenylketonuria, alkaptonuria, and maple syrup disease), biosynthesis of essential amino acids.

Practice - Verification of Beer-lambert's Law using Potassium Dichromate.

UNIT – IV: Neurophysiology and Neuromuscular Function

Sensory and motor nervous systems, neural pathways, and synaptic transmission. Higher nervous functions, reflex mechanisms, and cerebrospinal fluid dynamics. Blood-brain and blood-CSF barriers. Skeletal muscle properties, contraction-relaxation mechanisms, neuromuscular junction physiology, and sarcotubular system. Smooth muscle structure, signal transduction, and contraction mechanisms.

Practice - Demonstration of human physiology using 3D Models.

UNIT – V: Hematology, Cardiovascular Physiology, and Endocrine Regulation

Blood composition, hemopoiesis, erythropoiesis, and immune cell function. Hemostasis, clotting disorders, and blood group classification. Cardiac muscle properties, conduction system, cardiac cycle, and blood pressure regulation. Endocrine gland functions, hormonal control, and endocrine disorders. Respiratory mechanics, gas exchange, regulation of breathing, hypoxia, artificial ventilation, and non-respiratory lung functions.

Practice - Qualitative and Quantitative Analysis of Carbohydrates.

Textbooks:

1. Principles of Forensic Science and Toxicology by Rajesh Bardale.
2. Essentials of Forensic Medicine and Toxicology by K. S. Narayan Reddy.

Reference Books:

1. Recent Advances in Forensic Medicine – Volume 1 & 2
2. Forensic Science Handbook – Richard Saferstein

Web Links:

1. WHO Guidelines on Forensic Medicine
2. UK General Medical Council (GMC) Ethics
3. US Medicolegal Ethics and Forensic Pathology
4. International Committee of the Red Cross (ICRC) Guidelines
5. AI in Forensic Medicine Research

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
MSC 2: Forensic Chemistry & Toxicology											
2511FS07	III	Poisons and Pesticides	AC	2		2	4	50	50	100	-
2511FS08		Drug and Drug mechanisms	AC	3		1	4	50	50	100	-
2511FS09		Explosives	AC	2		2	4	50	50	100	-
2511FS10		Fire, Arson and Petroleum products	AC	3		1	4	50	50	100	-
2511FS11		Food and Beverages	AC	2		2	4	50	50	100	-
2511FS12		Environmental Toxicology	AC	3		1	4	50	50	100	-
Total				**15**		**9**	**24**				

MSC 2: Forensic Chemistry & Toxicology

Poisons and Pesticides

L	T	P	C
2	0	2	4

Course Code: 2511FS07
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental concepts of poisons, including their mechanisms of action, toxicity, and legal implications.
CO2: Analyze the classification and biochemical mechanisms of poisons, including their role in cellular damage.
CO3: Evaluate the classification, toxicological effects, and regulatory aspects of pesticides.
CO4: Apply forensic techniques for the examination, sampling, and analysis of poisons and pesticides.
CO5: Examine legal aspects, ethical considerations, and real-world case studies related to poisons and pesticides in forensic toxicology.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	2	2	2	-	1	-	-	-	1
CO2	2	2	-	3	2	-	1	-	-	-	1
CO3	1	1	2	2	2	-	1	-	-	1	1
CO4	2	3	-	2	3	-	2	-	-	-	1
CO5	1	1	3	-	2	-	2	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	3
CO2	3	1
CO3	2	2
CO4	2	2

CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Introduction to Poisons

Overview of Poisons, toxicants, and toxins; acute vs. chronic poisoning; routes of exposure. Mechanisms of Toxicity: Absorption, distribution, metabolism, and excretion (ADME); biochemical mechanisms. Toxicological Effects: Local and systemic effects; dose-response relationship; lethal dose (LD50) and effective dose (ED50). Mechanisms of Action: Cellular and molecular mechanisms of toxicity; role of reactive oxygen species and free radicals. Legal Aspects: Regulatory frameworks for poisons, forensic significance of poisons in criminal cases.

Practice - Simulation of ADME (Absorption, Distribution, Metabolism, and Excretion) using a model system.

UNIT – II: Classification and Mechanisms of Poisons

Classification of Poisons: Corrosive, irritant, systemic, neurotoxic, cardiac and asphyxiant poisons. Specific Toxicants: Heavy metals (arsenic, lead, mercury); alkaloids (nicotine, strychnine); and cyanides. Biochemical Mechanisms of Toxicity, Role of enzymes in poison metabolism (e.g., cytochrome P450). Mechanisms of cellular damage: oxidative stress, inhibition of protein synthesis, and interference with ion channels.

Practice - Qualitative analysis of heavy metals in biological and non-biological samples.

UNIT – III: Introduction to Pesticides

Overview and Classification of Pesticides. Toxicokinetics and Toxicodynamics: Metabolism of pesticides in humans and environmental persistence. Acute and Chronic Toxicity: Signs and symptoms of pesticide poisoning; long-term health effects (e.g., carcinogenicity). Regulation and Control: Pesticide Act; permissible exposure limits; food safety and residue analysis.

Practice - Detection of pesticide residues in food samples using QuEChERS extraction.

UNIT – IV: Forensic Examination of Poisons and Pesticides

Sampling techniques; chain of custody; documentation. Extraction Methods: Liquid-liquid extraction, solid-phase extraction, and other techniques, QuEChERS (quick, easy, cheap, effective, rugged, and safe). Instrumental Analysis: Tandem mass spectrometry (LC-MS/MS, GC-MS/MS); FTIR; NMR. Interpretation of Results: Quantitative and qualitative analysis; linking findings to toxicological significance.

Practice - Forensic analysis of poisons using GC-MS.

UNIT – V: Legal Aspects and Case Studies in Toxicology

Indian Poisons Act, 1919, and relevant legal provisions. Role of forensic toxicologists in crime investigation and court proceedings. Case studies of poisoning: Accidental, homicidal, and suicidal cases. Ethical considerations in forensic toxicology. Emerging trends and challenges in poison and pesticide toxicology.

Practice - Identification of toxic alkaloids (e.g., nicotine or strychnine) using thin-layer chromatography (TLC).

Textbooks

1. Casarett and Doull's Essentials of Toxicology by Curtis D. Klaassen and John B. Watkins III.

2. Textbook of Forensic Medicine and Toxicology by Nageshkumar G. Rao.

Reference Books

1. The Pharmacological Basis of Therapeutics by Goodman and Gilman.

2. Forensic Toxicology: Mechanisms and Pathology by Robert H. Powers and Geralyn M. Collins.

Weblinks

1. https://www.toxicology.org

2. https://pubs.acs.org/journal/txcpr3

3. https://www.fda.gov/food

4. https://www.who.int/health-topics/toxicology

5. https://www.niehs.nih.gov/research/topics/tox/index.cfm

Drug and Drug Mechanisms

L	T	P	C
3	0	1	4

Course Code: 2511FS08
Semester - III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental concepts of drugs, their classification, pharmacodynamics, and factors influencing drug action.
CO2: Analyze the principles of pharmacokinetics and the metabolism of drugs, including mechanisms of absorption and elimination.
CO3: Evaluate the molecular targets and mechanisms of action of major drug classes and their therapeutic applications.
CO4: Examine the mechanisms of drugs affecting major physiological systems and their pharmacological effects.
CO5: Explore advanced developments in drug mechanisms, including drug resistance, nanotechnology, and emerging therapeutics.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	2	2	2	-	1	-	-	-	1
CO2	2	2	-	3	2	-	1	-	-	-	1
CO3	2	1	2	3	2	-	1	-	-	-	1
CO4	2	2	-	2	3	-	1	-	-	-	1
CO5	2	1	3	2	2	1	1	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	3	-
CO3	3	-
CO4	2	1

CO5	2	1

Unit-Wise Syllabus:

UNIT - I: Introduction to Drugs and Pharmacodynamics

Definition and Classification of Drugs: Prescription drugs, over-the-counter drugs, illicit drugs, and biologics. Pharmacodynamics: Drug-receptor interactions; agonists and antagonists; signal transduction pathways. Therapeutic and Adverse Effects: Therapeutic index, drug efficacy, and potency. Factors Influencing Drug Action: Age, gender, genetics, and disease states. Drugs & Cosmetics Act 1945.

Practice - Study of dose-response relationships for a given drug using simulated experiments.

UNIT - II: Pharmacokinetics and Drug Metabolism

Principles of Pharmacokinetics: Absorption, distribution, metabolism, and excretion. Bioavailability and Bioequivalence: Concepts and factors affecting drug absorption. Drug Metabolism: Phase I (oxidation, reduction, hydrolysis) and Phase II (conjugation) reactions. Elimination Mechanisms: Renal and hepatic elimination; factors influencing drug clearance.

Practice - Analysis of drug metabolism by measuring enzyme activity (e.g., cytochrome P450 assay).

UNIT - III: Mechanisms of Drug Action

Molecular Targets of Drugs: Enzymes, ion channels, transporters, and receptors. Mechanism of Action of Major Drug Classes: Antimicrobial Drugs: Mechanisms of antibiotics, antivirals, and antifungals. Analgesics: Mechanisms of opioid and non-opioid analgesics. Anti-inflammatory Drugs: NSAIDs, corticosteroids. Signal Transduction. Pathways: G-protein coupled receptors, tyrosine kinase receptors, and ionotropic receptors.

Practice - Determination of minimum inhibitory concentration (MIC) of an antimicrobial drug.

UNIT - IV: Drugs Affecting Major Physiological Systems

Central Nervous System (CNS): Mechanisms of sedatives, stimulants, and antiepileptic drugs. Cardiovascular System: Mechanisms of antihypertensives, diuretics, and antiarrhythmic drugs. Endocrine System: Mechanisms of hormone replacement therapy and antidiabetic drugs. Immune System: Mechanisms of immunosuppressive and immunomodulatory drugs.

Practice - Evaluation of the effects of antihypertensive drugs on blood pressure in a simulated cardiovascular model.

UNIT - V: Advanced Developments in Drug Mechanisms

Drug Resistance Mechanisms: Antibiotic resistance, multidrug resistance in cancer. Nanotechnology in Drug Delivery: Role of nanoparticles and liposomes in targeted drug delivery. Pharmacogenomics: Genetic basis of drug response and personalized medicine. Emerging Therapeutics: Mechanisms of monoclonal antibodies, gene therapy, and RNA-based drugs.

Practice - Development and testing of liposome-based drug delivery systems in a laboratory setting.

Textbooks:

1. Parikh C.K. (1972). Forensic Medicine and Toxicology. India, Medical Publications.
2. Modi, R. B. J. P. (2013). A textbook of medical jurisprudence and toxicology. Elsevier.

Reference Books:

1. Clinical Pharmacology by Peter N. Bennett, Morris J. Brown, and Pankaj Sharma.

2. Molecular Biology of the Cell by Bruce Alberts.

Web Links:

1. Swayam- https://onlinecourses.swayam2.ac.in/ini24_bt04/preview
2. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_pg/697
3. https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/forensic-toxicology
4. https://pmc.ncbi.nlm.nih.gov/articles/PMC4832912/?utm_
5. https://www.alliant.edu/blog/what-is-forensic-pharmacology

Explosives

L	T	P	C
2	0	2	4

Course Code: 2511FS09
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the history, classification, and fundamental properties of explosives, as well as their applications.
CO2: Explain the chemical composition, synthesis, and environmental impact of explosives, along with safety protocols.
CO3: Analyze the effects of explosions, techniques for post-blast residue analysis, and investigation methodologies.
CO4: Apply forensic techniques for the identification and examination of explosives using advanced instrumentation.
CO5: Evaluate explosives regulations, detection, disposal techniques, and counter-terrorism measures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	-	1	-	-	-	1
CO2	2	2	-	3	2	-	1	-	-	1	1
CO3	2	3	1	3	3	-	2	-	-	1	1
CO4	2	2	-	2	3	-	2	-	-	1	1
CO5	2	1	3	-	2	-	2	-	-	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	2
CO2	2	2
CO3	3	1
CO4	2	1

CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Introduction to Explosives

History and development of explosives. Classification of explosives: Low explosives and high explosives. Properties of explosives: Sensitivity, stability, brisance, and detonation velocity. Mechanism of explosion and detonation theories. Applications of explosives in industries, military, and forensic science.

Practice - Sensitivity testing of an explosive material using impact or friction apparatus.

UNIT – II: Chemistry and Synthesis of Explosives

Chemical composition and synthesis of common explosives (TNT, RDX, PETN, HMX, ANFO). Homemade explosives and improvised explosive devices (IEDs). Role of oxidizers and fuels in explosive formulations. Environmental impact and degradation of explosives. Safety measures in handling and storage of explosives.

Practice - Synthesis and characterization of a simple explosive compound.

UNIT – III: Explosion Effects and Scene Investigation

Blast wave propagation and effects on structures and humans. Residue analysis and identification of post-blast components. Scene documentation and evidence collection in explosion cases. Analysis of bomb fragments and explosive traces. Case studies of major explosion incidents.

Practice - Post-blast residue analysis using chemical spot tests.

UNIT – IV: Forensic Analysis of Explosives

Presumptive and confirmatory tests for explosives. Instrumental techniques: Chromatography (TLC, GC-MS), Spectroscopy (FTIR, Raman), and X-ray diffraction. Detection of explosives in trace amounts. Legal aspects and forensic protocols in explosives examination. Role of forensic experts in explosive-related investigations.

Practice - Detection and identification of explosives using FTIR and GC-MS.

UNIT – V: Explosives Regulations and Countermeasures

National and international regulations on explosives (Explosives Act, UN conventions). Explosive detection techniques: Canines, sensor technology, and automated detection systems. Disposal and neutralization of explosives. Counter-terrorism measures and security protocols. Emerging trends and future challenges in explosives forensics.

Practice - Simulation of explosive detection using sensor technology.

Textbooks

1. "Explosives Engineering" by Paul W. Cooper.
2. "Introduction to Explosives" by Michael G. Gurney.

Reference Books

1. "Understanding Explosives" by A. Bailey and S.G. Murray.
2. "Military and Civilian Pyrotechnics" by George W. Weingart.

Weblinks

1. https://www.nrcan.gc.ca/explosives
2. https://www.atsdr.cdc.gov
3. https://www.osha.gov/explosives
4. https://www.fbi.gov/investigate/terrorism/explosives
5. https://www.interpol.int/Crimes/Terrorism/Improvised-explosive-devices-IEDs

Fire, Arson & Petroleum Products

Course Code: 2511FS10
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental principles of fire chemistry, combustion, and extinguishing techniques.
CO2: Analyze fire scenes, identify arson indicators, and apply fire debris analysis techniques.
CO3: Gain knowledge of the properties and forensic significance of petroleum products in fire investigations.
CO4: Apply advanced analytical techniques for detecting and analyzing fire debris and petroleum residues.
CO5: Evaluate the legal, environmental, and safety aspects of petroleum products and explore sustainable alternatives.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	-	1	-	-	1	1
CO2	2	3	3	3	3	-	2	-	-	1	1
CO3	2	1	1	2	2	-	1	-	-	1	1
CO4	2	3	3	3	3	-	2	-	-	1	1
CO5	2	1	1	-	2	-	2	-	-	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	2
CO3	2	1
CO4	3	2

CO5	2	3

Unit-Wise Syllabus:

UNIT - I: Fundamentals of Fire and Combustion

Fire chemistry: Elements of fire, stages of fire, fire triangle, and tetrahedron. Types of combustion: Complete and incomplete combustion, flash point, fire point, and ignition temperature. Classes of Fire, Classification of fires and fire extinguishers. Mechanism of flame propagation and fire suppression. Thermal decomposition and pyrolysis of materials.

Practice - Determination of flash point and fire point of liquid samples using a Pensky-Marten's apparatus.

UNIT- II: Fire Scene Investigation and Evidence Collection

Fire dynamics and fire spread patterns. Fire scene documentation: Photography, sketching, and notes. Collection, preservation, and transportation of fire debris evidence. Role of accelerants and ignitable liquids in fire cases. Interpretation of burn patterns, heat effects, and charring.

Practice - Collection and analysis of fire debris for accelerants using headspace sampling.

UNIT - III: Arson Investigation

Definition and types of arson: Accidental vs. deliberate fires. Indicators of arson: Multiple points of origin, presence of accelerants, and unusual burn patterns. Role of forensic chemistry in arson investigation. Analysis of fire residues and accelerants. Legal aspects of arson: BNS, BNSS, and BSA provisions and relevant sections.

Practice - Determination of the viscosity of petroleum products using a viscometer.

UNIT - IV: Petroleum Products and Their Forensic Analysis

Classification and composition of petroleum products. Methods of refining and processing: Distillation, cracking, and reforming. Characterization of petroleum products: Octane number, cetane number, viscosity, and flash point. Analytical techniques for petroleum product analysis: GC, GC-MS, FTIR. Illicit adulteration of fuels and forensic detection methods.

Practice - Identification of accelerants in fire debris using Gas Chromatography-Mass Spectrometry (GC-MS).

UNIT - V: Fire & Petroleum Dynamics

Fire Modeling: Use of computer simulations to understand fire spread and dynamics. Fire Safety Engineering: Design and evaluation of fire suppression systems and building codes. Petroleum Spill Management: Strategies for containment, clean-up, and environmental impact assessment. Risk Assessment: Fire hazards in industrial settings and mitigation techniques.

Practice - Analysis of petroleum spill contamination in soil or water samples using UV-Vis's spectroscopy.

Textbooks:

1. "Forensic Fire Scene Reconstruction" by David J. Icove and John D. DeHaan
2. "Principles of Fire Behavior" by James G. Quintiere.

Reference Books:

1. "Fire Investigation" by Niamh Nic Daeid and Margaret-Ann Bain.
2. "Fire Dynamics" by Dougal Drysdale.

Web Links:

1. https://www.interfire.org
2. https://www.nist.gov/el/fire-research-division-73300
3. https://www.usfa.fema.gov/prevention/arson/
4. https://www.sciencedirect.com/science/article/abs/pii/S1355030620300010
5. https://www.crime-scene-investigator.net/practical-applications-of-hydrocarbon-and-photoionization-detection-units-in-arson-investigations.html

Food and Beverages

L	T	P	C
2	0	2	4

Course Code: 2511FS11
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental concepts of food and beverage analysis, including classification, composition, and regulatory frameworks.
CO2: Identify and quantify food adulterants and contaminants using chemical and instrumental methods.
CO3: Analyze alcoholic and non-alcoholic beverages for authenticity, ethanol content, and potential fraud cases.
CO4: Investigate the toxicological implications of food and beverages, including natural toxins and poisoning cases.
CO5: Explore emerging trends in food and beverage forensics, including nanotechnology and DNA-based authentication.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	-	1	-	-	1	1
CO2	2	3	1	3	3	-	2	-	-	1	1
CO3	2	2	1	3	2	-	2	-	-	1	1
CO4	2	1	3	3	3	-	2	-	-	1	1
CO5	2	1	3	-	2	1	1	-	-	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	3
CO2	3	2
CO3	3	2
CO4	2	3

CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Introduction to Food & Beverage Analysis

Definition, classification, and composition of food and beverages. Importance of forensic analysis in food safety and quality control. Food adulteration: types, common adulterants, and their health effects. Regulatory framework: FSSAI, Codex Alimentarius, BIS, and international standards. Sampling methods and preservation techniques.

Practice - Detection of common adulterants in food samples using chemical tests.

UNIT – II: Chemical Analysis of Food Adulterants & Contaminants

Identification and quantification of food adulterants (e.g., synthetic colors, preservatives, pesticides, heavy metals). Techniques for detecting microbial contamination in food. Instrumental methods for food analysis: Chromatography (GC, HPLC), Spectroscopy (UV-Vis, FTIR), and Mass Spectrometry. Case studies on food adulteration and forensic investigations.

Practice - Quantitative analysis of heavy metals in food samples using Atomic Absorption Spectroscopy (AAS).

UNIT – III: Beverage Forensics & Alcohol Analysis

Classification of alcoholic and non-alcoholic beverages. Chemical composition and fermentation process of alcoholic beverages. Detection of illicit and counterfeit alcoholic products. Analytical techniques for ethanol content determination (e.g., GC, FTIR). Legal regulations and forensic case studies in beverage fraud.

Practice - Determination of ethanol content in alcoholic beverages using Gas Chromatography (GC).

UNIT – IV: Toxicology of Food & Beverages

Natural toxins in food: mycotoxins, phytotoxins, and bacterial toxins. Foodborne diseases and forensic implications. Forensic investigation of poisoning cases due to food and beverages. Detection and analysis of toxic compounds (e.g., methanol poisoning, pesticide residues). Role of forensic chemists in foodborne outbreak investigations.

Practice - Detection of pesticide residues in food samples using High-Performance Liquid Chromatography (HPLC).

Unit V: Emerging Trends in Food & Beverage Forensics

Nanotechnology applications in food safety. DNA-based methods for food authentication (e.g., PCR in meat and dairy products). Artificial intelligence and machine learning in food fraud detection. Recent advancements in food packaging and preservation technologies. Case studies on forensic analysis of food fraud and beverage adulteration.

Practice - DNA extraction and PCR-based authentication of food products.

Textbooks

1. "Food Analysis" by Suzanne Nielsen.
2. "Handbook of Food Chemistry" by Peter Chi Keung Cheung and Bhavbhuti M. Mehta.

Reference Books

1. "Principles of Food Chemistry" by John M. deMan.
2. "Forensic Chemistry" by Suzanne Bell.

Weblinks

1. https://www.fssai.gov.in
2. https://www.foodsafetynews.com
3. https://www.who.int/foodsafety
4. https://www.cdc.gov/foodsafety
5. https://www.fsis.usda.gov

Forensic Nanotechnology

L	T	P	C
3	0	1	4

Course Code: 2511FS12
Semester –III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental principles, synthesis, and characterization of nanomaterials.
CO2: Apply nanotechnology to analyze evidence in forensic science, including fingerprints and trace materials.
CO3: Utilize nano-enabled tools for the detection of drugs, adulterants, and environmental pollutants in forensic chemistry.
CO4: Analyze biological evidence and toxicological samples using advanced nanotechnology-based methods.
CO5: Explore tools and techniques like lab-on-a-chip and wearable sensors for real-time forensic applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	2	2	1	1	-	-	1	1
CO2	2	2	-	3	3	2	2	-	-	1	1
CO3	2	3	-	2	3	2	2	-	-	1	1
CO4	2	2	-	2	2	2	2	-	-	1	1
CO5	2	1	-	3	2	2	2	-	-	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	1
CO4	3	2

CO5	2	2

Unit-Wise Syllabus:

UNIT I- Fundamentals of Nanotechnology

Introduction to nanotechnology, definitions and concepts, history and evolution, comparison of nanoscale and bulk materials, types of nanomaterials- zero-dimensional nanomaterials, one-dimensional nanomaterials, two-dimensional nanomaterials, three-dimensional nanomaterials, organic nanomaterials, inorganic nanomaterials, synthesis techniques: top-down approaches, bottom-up approaches, characterization techniques: microscopy, spectroscopy, and other tools.

Practice - Synthesis of nanoparticles.

UNIT II- Nanotechnology in Forensic Science

Applications of Nanotechnology in crime scene investigations, nanoparticle-based latent fingerprint detection, explosive residue detection, trace evidence analysis, analysis of fibers and textiles, gunshot residue detection, nanoscale analysis in glass, soil, and paint, document examination, nano-forensics in ink and paper analysis, and tampered document authentication.

Practice - Characterization of nanoparticles.

UNIT III- Nanotechnology in Forensic Chemistry

Nano-enabled drug detection, nanosensors for controlled substances, Nanotechnology in chromatography and mass spectrometry, molecularly imprinted polymers, forensic applications in food testing, detection of adulterants, nano-enabled alcohol quantification, Nanomaterials in pollutant detection, and Nano-toxicological effects.

Practice - Detection of poisons using nanoparticles.

UNIT IV- Nanotechnology in Forensic Toxicology

Detection of toxicological evidence, nanoparticles in DNA analysis, nano-probes for body fluids, toxicological studies, nano-based detection of poisons, quantum dots for toxin studies, nanotechnology in drug metabolism, advanced biosensors, nano-biosensors, and graphene-based and plasmonic biosensors.

Practice - Detection of pesticide using nanoparticles.

UNIT V- Advanced Tools and Applications in Forensic Nanotechnology

Nano-diagnostic tools, lab-on-a-chip technologies, Microfluidic devices, nanotechnology in wearable sensors for forensic investigations, real-time crime scene analysis using nanotechnology, portable nanoparticle-based detection systems, hybrid nanomaterial synthesis, and integration of nanotechnology with blockchain for forensic data management.

Practice - Detection of heavy metals using nanoparticles**.**

Textbooks

1. Nanotechnology: The Science of Small by M.A. Shah and K.A. Shah.
2. Forensic Applications of Nanotechnology by Zoran Zdravković.

Reference Books

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao and Ying Wang.

2. Introduction to Nanoscience and Nanotechnology by Gabor L. Hornyak et al.

Weblinks

1. https://www.nano.gov

2. https://www.nanotechnologyworld.org

3. https://www.sciencedirect.com

4. https://onlinelibrary.wiley.com

5. https://www.rsc.org

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
MSC 3: Questioned Document & Fingerprint Science											
2511FS13	III	Advanced Handwriting & Signature Examination	AC	2		2	4	50	50	100	-
2511FS14		Advanced Document Forgery Analysis	AC	3		1	4	50	50	100	-
2511FS15		Paper & Ink Analysis	AC	2		2	4	50	50	100	-
2511FS16		Advanced Fingerprint Development & Ridgeology	AC	3		1	4	50	50	100	-
2511FS17		Advanced Fingerprint Examination	AC	2		2	4	50	50	100	-
2511FS18		Advanced Impression Evidence Analysis	AC	3		1	4	50	50	100	-
Total				**15**		**9**	**24**				

MSC 3: Questioned Document & Fingerprint Science

Advanced Handwriting & Signature Examination

L	T	P	C
2	0	2	4

Course Code: 2511FS13
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Develop an in-depth understanding of handwriting and signature examination principles.

CO2: Differentiate between genuine and forged signatures using forensic methodologies.

CO3: Apply modern tools such as VSC, hyperspectral imaging, and biometric authentication in document examination.

CO4: Examine handwriting and signature evidence in forensic cases, considering medical, environmental, and psychological influences.

CO5: Evaluate legal frameworks, ethical considerations, and admissibility of handwriting and signature evidence in courts.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	-	2	-	-	-	1
CO2	2	2	1	3	3	-	2	-	-	-	1
CO3	1	3	2	2	3	1	2	1	-	-	1
CO4	1	2	1	2	2	-	2	-	2	-	1
CO5	1	1	2	-	2	-	3	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	1
CO3	2	2
CO4	3	2
CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Handwriting Examination

History and Evolution of Handwriting Analysis, Scope and Importance of Forensic Handwriting Examination, Psychological and Neurological Aspects of Handwriting, Influence of Writing Ergonomics and Motor Skills, Scientific Basis of Handwriting Individuality, Detailed Analysis of Writing Strokes, Fluency, and Pen Pressure, Identification of Hesitations, Pen Lifts, and Patching, Examination of Signatures in Different Languages and Scripts, Factors Affecting Handwriting Consistency, Role of Forensic Handwriting Experts in Civil and Criminal Cases.

Practice - To study the effect of writing ergonomics on handwriting characteristics.

UNIT – II: Signature Forgery & Detection Techniques

Types of Signature Forgeries – Manual, Mechanical, and Digital, Behavioral Aspects Influencing Signature Variations, Signature Fraud in Financial Crimes and Legal Documents, Detection of Disguised and Auto-Forged Signatures, Analysis of Pen Lifts, Rhythm, and Natural Flow in Signatures, Ink and Pressure Distribution Analysis, Signature Duplication Through Photocopying, Scanning, and Tracing, AI and Machine Learning-Based Signature Verification, Case Studies of High-Profile Signature Frauds, Legal Aspects of Signature Examination in Forensic Cases.

Practice - To differentiate between genuine and forged signatures based on natural variations.

UNIT – III: Instrumental Techniques in Document Examination

Advanced Forensic Tools in Handwriting and Signature Examination, Role of Imaging Techniques in Document Verification, Spectral and Microscopic Analysis of Strokes and Ink Flow, Video Spectral Comparator (VSC) in Ink Differentiation, Electrostatic Detection Apparatus (ESDA) in Detecting Indentations, Raman Spectroscopy and Hyperspectral Imaging in Ink and Paper Analysis, 3D Forensic Handwriting Analysis, Application of Biometric Handwriting Recognition Systems, Integration of AI in Forensic Handwriting and Signature Analysis.

Practice - To study handwriting strokes under a microscope for forensic analysis.

UNIT – IV: Examination of Handwriting & Signatures in Forensic Cases

Challenges in Handwriting Examination Involving Medical Conditions (e.g., Parkinson's, Arthritis, and Aging), Examination of Disguised and Anonymous Writings, Comparative Analysis of Original vs. Forged Signatures, Variability in Handwriting Due to External Influences (Lighting, Surface, Writing Instrument), Handwriting Comparison Techniques in Disputed Wills, Suicide Notes, and Contracts, Establishing Authorship in Questioned Documents, Role of Forensic Document Examiners in Financial Fraud Investigations, Importance of Maintaining Chain of Custody in Handwriting Evidence, Scientific Validation of

Handwriting and Signature Analysis, Role of Forensic Document Examiners in Criminal and Civil Cases.

Practice - To study handwriting variations caused by medical conditions like Parkinson's and arthritis.

UNIT – V: Legal Framework & Ethical Considerations in Handwriting & Signature Examination

Forensic Expert Testimony in Handwriting and Signature Cases, International Standards and Protocols in Document Examination, Ethical Challenges in Forensic Handwriting Analysis, Role of Forensic Document Examiners in Fraud and Identity Theft Cases, Legal Provisions Governing Questioned Document Examination – Bharatiya Nyaya Sanhita (BNS), Bharatiya Nagarik Suraksha Sanhita (BNSS), and Bharatiya Sakshya Adhiniyam (BSA), Admissibility of Handwriting and Signature Evidence in Courts, Guidelines in Forensic Reporting and Documentation, Standard Operating Procedures in Forensic Handwriting Analysis, Impact of Forensic Handwriting and Signature Examination in Criminal Justice, Future Advancements and Research in Forensic Handwriting Science.

Practice - To discuss ethical challenges in forensic handwriting examination.

Textbooks:

1. Hilton, O. (1993). *Scientific examination of questioned documents.* CRC Press.
2. Harrison, W. R. (2008). *Suspect documents: Their scientific examination.* Universal Law Publishing.
3. Huber, R. A., & Headrick, A. M. (1999). *Handwriting identification: Facts and fundamentals.* CRC Press.
4. Koppenhaver, K. (2007). *Forensic document examination: Principles and practice.* Humana Press.
5. Kelly, J. S., & Lindblom, B. S. (2006). *Scientific examination of questioned documents.* CRC Press.

Reference books:

1. Saxena, S. (2015). *Handwriting and signature analysis in forensic science.* Springer.
2. Ellen, D. (1997). *The scientific examination of documents: Methods and techniques.* CRC Press.

Web Links:

1. https://regulaforensics.com/blog/forensic-handwriting-examination/
2. https://dekalbmiller.com/forensic-handwriting-analysis/
3. https://pmc.ncbi.nlm.nih.gov/articles/PMC8330766/
4. https://www.intechopen.com/chapters/89561
5. https://www.dnaforensics.in/tests/forensic-tests/signature-verification

Advanced Documents Forgery Analysis

L	T	P	C
3	0	1	4

Course Code: 2511FS14
Semester - III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the historical significance and scientific principles underlying handwriting individuality and document forgery.
CO2: Analyze handwriting variations, disguised writing, and document alterations using advanced forensic techniques.
CO3: Examine forged documents through instrumental methods such as VSC, ESDA, and spectroscopy-based techniques.
CO4: Identify forged signatures and handwriting inconsistencies using forensic analysis of rhythm, pressure, and tremors.
CO5: Evaluate the legal framework, ethical considerations, and admissibility of handwriting and forgery evidence in court.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	-	2	-	-	-	1
CO2	2	2	1	3	3	1	2	-	-	-	1
CO3	2	3	1	2	3	1	2	1	-	-	1
CO4	2	2	1	2	3	-	2	-	2	-	1
CO5	2	1	3	-	2	-	3	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	2
CO3	2	2

CO4	3	2
CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Theoretical Foundations of Forgery Analysis

Evolution and Historical Significance of Document Forgery, Psychological Profiling of Document Forgers, Differences Between Amateur and Professional Forgeries, Role of Motor Skills and Neurophysiology in Handwriting Forgery, Determination of Document Authenticity in Historical and Legal Records, Scientific Principles Underlying Handwriting Individuality, Examination of Habitual Writing Characteristics in Forgery Cases, Influence of External Factors on Handwriting Variations, Role of Forensic Document Examiners in Criminal and Civil Investigations, Case Studies of Significant Document Forgery Cases.

Practice - To study the influence of motor skills and neurophysiology on handwriting forgery.

UNIT – II: High-Precision Techniques in Forgery and Alteration Detection

Microanalysis of Paper Fibres and Ink Particles in Forged Documents, Spectrographic Differentiation of Inks and Pigments, Application of Fourier Transform Infrared Spectroscopy (FTIR) in Document Examination, High-Resolution Imaging Techniques for Detecting Erasures and Additions, Algorithm-Based Handwriting Variation Analysis for Forgery Detection, Latent Writing and Impression Detection Using Advanced Imaging, Identification of Substituted and Tampered Pages in Official Documents, Examination of Chemical Erasures and Solvent-Based Alterations, Techniques for Detecting Disguised Handwriting in Forged Documents, Case Studies on Sophisticated Handwriting Forgeries.

Practice - To detect chemical erasures and solvent-based alterations in forged documents.

UNIT – III: Instrumental Techniques for Advanced Document Examination

Video Spectral Comparator (VSC) for Ink and Security Feature Analysis, Electrostatic Detection Apparatus (ESDA) for Identifying Indentations, Raman and Hyperspectral Imaging for Forgery Detection, Micro-XRF Spectroscopy for Non-Destructive Element Analysis in Paper and Ink, Gas Chromatography-Mass Spectrometry (GC-MS) for Ink Composition Analysis, Thin Layer Chromatography (TLC) for Differentiating Ink Formulations, Optical and Fluorescence Techniques for Detecting Security Document Alterations, Magnetic and Infrared Analysis of Security Inks, Advanced Techniques for Detecting Pressure Variations in Forgeries, Forensic Microscopy for Detecting Unnatural Stroke Formations.

Practice - To analyze ink composition in questioned documents using TLC.

UNIT – IV: Forensic Examination of Handwriting and Signature Forgery

Identification of Pen Lifts, Tremors, and Unnatural Hesitations in Forged Handwriting, Detection of Forgery Through Speed, Rhythm, and Pen Pressure Analysis, Influence of Writing Position, Surface, and Instrument on Forged Handwriting, Examination of Simulated, Traced, and Freehand Forgeries, Techniques for Identifying Disguised and Unnatural Handwriting Patterns, Effects of Aging, Illness, and Writing Conditions on Handwriting Consistency, Methods for Establishing Authorship in Questioned Signatures, Role of Forensic Handwriting Experts in Financial and Legal Fraud Cases, Forensic Analysis of Altered and Disguised Documents in High-Profile Cases, Chain of Custody and Documentation of Forensic Handwriting Evidence.

Practice - To identify disguised handwriting patterns in forged signatures

UNIT – V: Legal and Ethical Considerations in Advanced Forgery Examination

Forensic Expert Testimony in Complex Forgery Cases, Legal Standards for Forensic Document Examination, Ethical Responsibilities of Forensic Document Examiners, National and International Legal Frameworks Governing Document Authentication, Role of Forensic Document Analysis in Fraud and Identity Theft Cases, Admissibility of Forensic Handwriting and Document Evidence in Court, Standard Operating Procedures for Forensic Document Analysis, Challenges in Forensic Examination of Historical and Aged Documents, Scientific Validation of Forensic Handwriting and Forgery Detection Techniques, Future Advancements and Research in Forensic Document Examination.

Practice - To evaluate the admissibility of forensic handwriting evidence in court proceedings.

Textbooks:

1. Ellen, D. (1997). *The scientific examination of documents: Methods and techniques.* CRC Press.
2. Hilton, O. (1993). *Scientific examination of questioned documents.* CRC Press.

Reference Books:

1. Saxena, S. (2015). *Handwriting and signature analysis in forensic science.* Springer.
2. Srihari, S. N., & Cha, S. H. (2002). Individuality of handwriting: A validation study. *Journal of Forensic Sciences, 47*(4), 856–872. https://doi.org/10.1520/JFS15416J.

Web links:

1. https://www.aafs.org/
2. https://www.swgdoc.org/
3. https://www.nist.gov/topics/forensic-science
4. https://www.journals.elsevier.com/forensic-science-international
5. https://www.fbi.gov/investigate/forensics/questioned-documentts

Paper & Ink Analysis

L	T	P	C
2	0	2	4

Course Code: 2511FS15
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental principles of forensic paper and ink analysis.
CO2: Study the composition, classification, and manufacturing processes of paper and ink.
CO3: Explore advanced techniques for identifying paper types, fiber content, and security features.
CO4: Examine instrumental methods for ink differentiation and detection of alterations.
CO5: Apply forensic techniques for detecting forgery, fraud, and counterfeit documents.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	-	2	-	-	-	1
CO2	1	1	1	2	2	-	1	-	-	-	1
CO3	2	2	1	3	3	1	2	-	-	-	1
CO4	2	3	1	3	3	1	2	-	-	-	1
CO5	1	2	3	2	3	-	3	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	-
CO3	2	1
CO4	2	1
CO5	3	2

Unit-Wise Syllabus:

UNIT – I: Fundamentals of Paper Analysis

Introduction to Forensic Paper Analysis, History and Evolution of Paper Manufacturing, Raw Materials Used in Papermaking – Wood Pulp, Cotton Fibers, and Synthetic Fibers, Paper Manufacturing Processes – Chemical Pulping, Mechanical Pulping, and Recycling Methods, Classification of Paper Based on Gsm (Grams Per Square Meter), Fiber Content, and Surface Finish, Optical and Physical Properties – Brightness, Gloss, Smoothness, and Porosity, Identification of Paper Defects and Inconsistencies, Forensic Importance of Paper In Questioned Document Examination, Security Features In Official Documents – Watermarks, Security Threads, Holograms, and UV-Reactive Fibers, Techniques for Identifying Artificially Aged or Altered Paper Documents.

Practice - To study the classification and identification of different types of paper.

UNIT – II: Paper Examination Techniques

Morphological Analysis of Paper Fibers Using Scanning Electron Microscopy (Sem), Determination of Fiber Origin Using Polarized Light Microscopy Chemical Analysis of Paper Components – Fourier Transform Infrared Spectroscopy, X-Ray Diffraction, and Thermogravimetric Analysis , Characterization Of Fillers, Coatings, and Additives In Paper, Examination of Paper Density and Thickness Variations Using Non-Destructive Methods, Differentiation of Natural Vs. Synthetic Fibers In Paper Composition, Environmental Effects on Paper Aging – Humidity, Temperature, and Chemical Exposure, Paper Dating Techniques Based on Degradation Analysis, Detection of Fraudulently Substituted Pages In Multi-Page Documents.

Practice - To study fibre analysis of paper using a microscope.

UNIT – III: Ink Composition and Formulation

Historical Development of Writing Inks, Classification of Inks – Water-Based, Oil-Based, Alcohol-Based, and Hybrid Inks, Composition of Different Ink Types – Writing Inks, Printing Inks, Security Inks, and UV-Sensitive Inks, Role of Pigments, Dyes, Resins, and Solvents In Ink Formulation, Additives Used In Ink – Surfactants, Preservatives, and Viscosity Modifiers, Factors Affecting Ink Adhesion and Absorption on Different Paper Types, Methods of Ink Application – Pen, Stamp, Printing Press, And Digital Printing, Ink Drying Mechanisms – Evaporation, Absorption, and Oxidation, Influence of Environmental Conditions on Ink Stability and Fading, Methods for Artificial Ink Aging and Their Forensic Implications**.**

Practice - To study ink examination using thin layer chromatography.

UNIT – IV: Instrumental Techniques in Ink Analysis

Comparative Ink Analysis Using Spectrophotometry and Colorimetry, Identification of Ink Components Using Raman Spectroscopy, Fourier Transform Infrared Spectroscopy, And X-Ray Fluorescence ,High-Performance Thin Layer Chromatography and Capillary Electrophoresis for Ink Differentiation, Detection of Ink Tampering Using UV-Visible (UV-Vis) Spectroscopy, Electrochemical Analysis of Ink Degradation and Oxidation States, Analysis of Non-Visible Ink Alterations Using Hyperspectral Imaging and Multispectral Imaging , Determination of Ink Aging Using Solvent Evaporation and Migration Studies, Forensic Examination Of Inks on Non-Paper Surfaces – Walls, Fabric, And Plastics.

Practice - To study ink differentiation using UV-Vis's spectroscopy.

UNIT – V: Forensic Applications of Paper & Ink Analysis

Detection of Forged and Altered Documents Using Paper and Ink Analysis, Examination of Fraudulent Modifications In Legal Documents, Financial Records, and Historical Manuscripts, Identification of Invisible Ink and Chemical Erasures, Reconstruction of Burned or Water-Damaged Inked Documents, Differentiation Between Genuine and Counterfeit Currency Based On Paper and Ink Properties, Authentication of Handwritten and Printed Documents Using Material Analysis, Use of Artificial Intelligence (Ai) and Machine Learning In Forensic Ink And Paper Verification, Role of Blockchain and Cryptographic Methods In Digital Document Security, Legal Considerations and Admissibility of Forensic Paper and Ink Analysis In Court, Standard Operating Procedures for Forensic Laboratories Handling Paper And Ink Evidence.

Practice - To study hyperspectral imaging for ink and paper analysis.

Textbooks:

1. Brunelle, R. L., & Reed, R. W. (1984). *Forensic examination of ink and paper.* Charles C. Thomas Publisher.
2. Cantu, A. A. (2008). *Scientific examination of questioned documents.* CRC Press.

References:

1. Jasuja, O. P., Kumar, P., & Singh, G. (2015). Differentiation of inks by thin-layer chromatography for forensic examination of questioned documents. *Egyptian Journal of Forensic Sciences*, *5*(3), 89–95. https://doi.org/10.1016/j.ejfs.2015.01.004.
2. Boguslavsky, L. (2018). Raman spectroscopy for forensic ink analysis: Recent advancements and challenges. *Forensic Chemistry, 8,* 1–10.

Web Links:

1. https://www.aafs.org/
2. https://www.swgdoc.org/
3. https://www.nist.gov/topics/forensic-science
4. https://www.rsc.org/
5. https://www.fbi.gov/investigate/forensics/questioned-documents

Advanced Fingerprint Development & Ridgeology

L	T	P	C
3	0	1	4

Course Code: 2511FS16
Semester – III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the scientific foundations of ridgeology, including friction ridge formation, genetic influences, and ridge structure anomalies.

CO2: Explore and apply advanced latent fingerprint development techniques, including nanotechnology-based and spectroscopic methods.

CO3: Analyze complex fingerprint casework, including ridge distortions, postmortem fingerprint recovery, and forensic differentiation of similar prints.

CO4: Utilize instrumental and chemical methodologies for fingerprint residue analysis and development.

CO5: Address legal, ethical, and procedural challenges in fingerprint examination, ensuring adherence to forensic standards and minimizing errors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	1	2	-	-	-	1
CO2	2	3	-	3	3	2	2	-	-	-	-
CO3	1	2	-	2	2	2	2	-	1	-	1
CO4	2	2	-	2	2	2	2	-	-	-	1
CO5	1	1	3	-	2	-	3	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	2
CO4	3	2
CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Scientific Basis of Ridgeology

Biomechanics and Embryology of Friction Ridge Formation, Genetic and Epigenetic Factors Influencing Ridge Patterns, Ridge Structure Anomalies – Ridge Hypoplasia, Dysplasia, and Ridge Bifurcation Abnormalities, The Impact Of Age, Disease, and Environmental Exposure on Ridge Clarity and Persistence, Comparative Ridge Analysis Across Different Species, Advanced Ridge Characteristics – Edgeoscopy, Poroscopy, and Ridge Unit Morphology, Pressure Dynamics and Fingerprint Distortion Analysis, Computational Modeling of Ridge Pattern Variability, Standardization Challenges in Forensic Ridgeology.

Practice - To study ridge structure anomalies.

UNIT – II: Latent Fingerprint Development Techniques

Nanotechnology-Based Fingerprint Reagents – Quantum Dots, Metal Nanoparticles, and Conductive Polymers, Ultra-Sensitive Fingerprint Visualization Using Super-Resolution Microscopy, Thermochemical Techniques for Fingerprint Recovery from Extreme Environments, Plasma-Assisted Latent Print Enhancement, Supercritical Fluid Extraction for Chemical Profiling of Fingerprint Residues, Advanced Spectroscopic Fingerprint Detection – Surface-Enhanced Raman Spectroscopy (Sers), Synchrotron-Based X-Ray Fluorescence, Age Estimation of Latent Fingerprints Through Lipid Degradation And Environmental Exposure Analysis, Multi-Layered Fingerprint Residue Analysis for Sequential Contact Determination, Fingerprint Detection On Unconventional Surfaces – Skin, Fabrics, Explosives, and Burned Documents.

Practice - To study the development of latent fingerprints using nanotechnology.

UNIT – III: Ridgeology in Complex Casework

Forensic Analysis of Pressure-Induced Ridge Distortion, Ridge Skin Deformation Mapping from Curved and Irregular Surfaces, Reconstruction of Incomplete and Fragmented Fingerprints from Crime Scenes, Ridge Similarity Assessment In Close Non-Matching Prints – Understanding Inter-Individual Variations, Examination of Ridge Persistence and Ridge Reformation After Injuries, Analysis of Postmortem Fingerprint Changes – Recovery Of Prints From Decomposed, Burned, And Mummified Bodies, Identical Twin Fingerprint Differentiation Based on Third-Level Ridge Characteristics, Ridge Drift And Fusion Studies In Aging And Disease Conditions, Multi-Source Fingerprint Deconvolution for Complex Mixture Prints.

Practice - To study the chemical analysis of fingerprint residues.

UNIT – IV: Instrumental and Chemical Analysis in Fingerprint Development

Spectroscopic Fingerprint Residue Analysis – Fourier Transform Infrared Spectroscopy , Raman Spectroscopy, And X-Ray Fluorescence, Electrochemical Fingerprint Residue Profiling For Drug and Toxin Detection, Biochemical Fingerprint Composition Analysis – Amino Acids, Lipids, and Metabolites, Latent Print Recovery From Submerged Objects Using Solvent Extraction Methods, Role of Reactive Oxygen Species (Ros) In Fingerprint Oxidation And Detection, Investigation Of Artificial Fingerprint Aging and Environmental Effects on Fingerprint Residues, Hybrid Methodologies Integrating Physical and Chemical Fingerprint Development Techniques.

Practice - To study the differentiation of identical twin fingerprints.

UNIT – V: Legal and Ethical Challenges in Advanced Fingerprint Examination

Admissibility of Advanced Fingerprint Techniques in Forensic Investigations, Error Rates in Ridgeology-Based Fingerprint Comparisons, Standardization and Validation Challenges In Forensic Fingerprint Examination, Cross-Jurisdictional Issues in International Fingerprint Databases and Interoperability, Ethical Concerns in Biometric Fingerprint Collection and Storage, Countermeasures Against Fingerprint Spoofing and Synthetic Fingerprint Replication, Bias and Human Cognitive Errors In Forensic Fingerprint Comparisons, Legal Disputes and Wrongful Convictions Due To Erroneous Fingerprint Analysis, Future Trends In Forensic Ridgeology – Integration Of Forensic Chemistry, Neuro Forensics, and Ai-Driven Pattern Recognition.

Practice - To study the detection of fingerprint alterations and erasures.

Textbooks:

1. Champod, C., Lennard, C., Margot, P., & Stoilovic, M. (2016). *Fingerprints and Other Ridge Skin Impressions* (2nd ed.). CRC Press.
2. Lee, H. C., & Gaensslen, R. E. (2001). *Advances in Fingerprint Technology* (2nd ed.). CRC Press.

Reference Books:

1. Ashbaugh, D. R. (1999). *Quantitative-Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced Ridgeology*. CRC Press.
2. Stoney, D. A., & Thornton, J. I. (1986). *A Critical Analysis of Quantitative Fingerprint Individuality Models*. Journal of Forensic Sciences.

Web Links:

1. https://www.nist.gov/forensic-science/latent-fingerprint-detection
2. https://www.fbi.gov/services/cjis/fingerprints-and-other-biometrics
3. https://www.interpol.int/en/Crimes/Forensics/Fingerprints
4. https://nij.ojp.gov/topics/articles/development-and-validation-latent-fingerprint-technologies

Advanced Fingerprint Examination

L	T	P	C
2	0	2	4

Course Code: 2511FS17
Semester - III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the biological, genetic, and environmental factors influencing fingerprint formation and variability.
CO2: Explore advanced techniques for fingerprint visualization, development, and enhancement on various surfaces.
CO3: Study the role of artificial intelligence, machine learning, and automation in modern fingerprint analysis.
CO4: Examine the legal, ethical, and quality control aspects of fingerprint identification in forensic science.
CO5: Research emerging trends and innovative applications in forensic fingerprint examination.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	1	2	-	-	1	1
CO2	1	3	-	3	3	2	2	-	-	-	1
CO3	2	2	-	3	3	2	2	1	-	-	1
CO4	2	1	3	-	2	-	3	-	-	1	1
CO5	1	1	1	3	2	2	2	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	1

CO4	2	3
CO5	3	2

Unit-Wise Syllabus:

UNIT – I: Concepts in Fingerprint Science

Biological and Genetic Basis of Friction Ridge Formation, Micro and Nano-Level Ridge Detail Analysis, Persistence, Aging, and Degradation of Fingerprint Patterns, Comparative Analysis of Human and Animal Friction Ridge Skin, Forensic Implications of Skin Diseases on Fingerprint Identification, Post-Mortem Fingerprint Analysis and Tissue Decomposition Effects, Influence of Genetic and Environmental Factors on Fingerprint Variability, Forensic Intelligence from Fingerprints and Criminal Profiling, Ethical Considerations in Fingerprint Biometric Systems**.**

Practice - To analyse the effect of environmental factors on fingerprint degradation.

UNIT – II: Development and Enhancement Techniques

Development of Latent Prints from Thermal Paper, Textiles, and Wet Surfaces, Chemical and Physical Methods for Latent Print Detection, Nanotechnology-Based Fingerprint Visualization Techniques, Quantum Dot and Graphene Applications in Latent Print Detection, Multispectral and Hyperspectral Imaging in Fingerprint Enhancement, Forensic Enhancement of Partial, Smudged, and Low-Quality Prints, Advanced Algorithms for Distorted and Overlapping Print Analysis, Impact of Environmental and Chemical Exposure on Fingerprint Stability, Vacuum Metal Deposition (VMD) and Specialized Development Techniques**.**

Practice - To compare the effectiveness of chemical and physical fingerprint development techniques.

UNIT – III: Automated Fingerprint Identification System

Introduction to AFIS, Principles of Fingerprint Identification, Structure and Working of AFIS, Fingerprint Scanning Process and Image Enhancement, Fingerprint Matching Algorithms (Minutiae-Based Matching, Pattern Matching, Classification), Database Management and Search Techniques, Accuracy, Efficiency, and Matching Process in AFIS, Challenges in AFIS (Quality of Fingerprint Images, False Positives and Negatives, Data Privacy and Security), Applications of AFIS in Criminal Investigations, Civil Identification, and Database Comparisons, Advancements in AFIS Technology (Multi-Fingerprint Recognition, Live-Scan Technology, 3D Fingerprint Recognition), Case Studies and Real-World Applications in Forensic Science.

Practice - To investigate the impact of different surfaces on fingerprint quality and clarity.

UNIT – IV: Biometrics

Introduction to Fingerprint-Based Biometrics, Principles of Fingerprint Recognition, Anatomy of Fingerprints and Unique Features (Ridges, Minutiae Points), Types of Fingerprint Scanning Technologies (Optical, Capacitive, Ultrasound, Thermal), Fingerprint Image Acquisition and Enhancement Techniques, Fingerprint Matching Algorithms (Minutiae-Based Matching, Pattern Matching, Correlation-Based Matching), Fingerprint Classification and Search Techniques, Fingerprint Database Management and Search Efficiency, Accuracy and Performance of Fingerprint Recognition Systems, Applications of Fingerprint Biometrics in Security, Forensic Investigations, and Access Control, Challenges in Fingerprint-Based Biometrics (Quality of Prints, False Positives and Negatives), Ethical and Legal Considerations (Privacy, Data Security, and Consent), Advancements in Fingerprint Biometrics (Live-Scan, Multi-Fingerprint Matching, 3D Fingerprint Recognition), Future Directions in Fingerprint-Based Biometric Systems.

Practice - To assess the reliability of multispectral and hyperspectral imaging in fingerprint enhancement.

UNIT – V: Research, Emerging Trends, and Practical Applications

Post-Mortem Fingerprint Analysis in Disaster Victim Identification (DVI), Latent Print Development from Burnt and Decomposed Bodies, Forensic Applications of AI-Based Fingerprint Reconstruction, Forensic Intelligence from Fingerprints: Linking Cases and Criminal Networks, Simulation and 3D Reconstruction of Fingerprints for Criminal Investigations, Research Methodologies in Fingerprint Forensics.

Practice - To examine forensic documentation and report writing standards for fingerprint examination.

Textbooks:

1. Champod, C., Lennard, C., Margot, P., & Stoilovic, M. (2016). *Fingerprint Detection and Identification: Advances and Challenges*. CRC Press.
2. Ashbaugh, D. R. (1999). *Quantitative-Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced Ridgeology*. CRC Press.

Reference Books:

1. Cowger, J. F. (1992). *Friction Ridge Skin: Comparison and Identification of Fingerprints*. CRC Press.
2. Wertheim, P. A. (2011). *Scientific Foundations of Fingerprint Identification*. AuthorHouse.

Web Links:

1. https://www.nist.gov/forensic-science/latent-fingerprint-detection
2. https://www.fbi.gov/services/cjis/fingerprints-and-other-biometrics
3. https://www.interpol.int/en/Crimes/Forensics/Fingerprints
4. https://nij.ojp.gov/topics/articles/development-and-validation-latent-fingerprint-technologies
5. https://www.rcmp-grc.gc.ca/en/fingerprint-identification

Advanced Impression Evidence Analysis

L	T	P	C
3	0	1	4

Course Code: 2511FS18
Semester - III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the genetic, biomechanical, and environmental factors influencing impression evidence formation and degradation.
CO2: Explore advanced techniques for collection, preservation, enhancement, and comparison of impression evidence.
CO3: Analyze forensic applications of digital imaging, nanotechnology, and AI in impression evidence examination.
CO4: Study legal, ethical, and quality control aspects of impression evidence admissibility in court.
CO5: Investigate emerging trends and forensic research methodologies in impression evidence analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	1	2	-	-	-	1
CO2	2	3	-	3	3	-	2	-	-	-	1
CO3	1	2	-	3	3	2	2	1	-	-	1
CO4	2	1	3	-	-	-	3	-	-	-	1
CO5	2	1	-	2	2	2	2	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	3	2
CO4	2	3

CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Concepts in Impression Evidence Analysis

Genetic and Environmental Influences on Impression Patterns, Persistence and Degradation of Impression Evidence, Forensic Significance of Pressure, Weight Distribution, and Stride Variations in Impressions, Forensic Gait Analysis and Dynamic Footprint Examination, Forensic Intelligence from Impression Evidence in Crime Linkage, Biomechanical Analysis of Impression Formation, Effect of Aging and Disease on Impression Patterns, Forensic Implications of Artificially Altered Impressions, Forensic Simulation and 3D Modeling of Impressions, Forensic Analysis of Pressure Distribution in Dynamic Impressions, Influence of Footwear and Gait Abnormalities on Impression Variability.

Practice - To study the effect of pressure and weight distribution on impression formation.

UNIT – II: Collection, Preservation, and Enhancement Techniques

Multi-Spectral and Hyperspectral Imaging in Impression Evidence Analysis, Nanotechnology in Impression Visualization and Enhancement, Advanced Digital Scanning and Photogrammetry for Impression Documentation, Forensic Enhancement of Impressions on Challenging Substrates (Fabric, Skin, Thermal Paper), Forensic Preservation of Submerged and Snow Impressions, Vacuum Metal Deposition (VMD) for Trace Impression Development, AI-Based Enhancement of Faint and Degraded Impressions, Forensic Recovery of Impressions from Explosive and Fire-Damaged Crime Scenes, Forensic Study of Impression Formation in Various Weather Conditions, Advanced Casting Materials for Three-Dimensional Impressions, Forensic Analysis of Latent Palm and Toe Prints, Best Practices in Preserving Trace Elements Within Impression Evidence.

Practice - To examine the use of multispectral imaging for enhancing faint impressions.

UNIT – III: Comparative Analysis of Impression Evidence

Forensic Examination of High-Impact Tool Marks and Microscopic Striations, Advanced Footwear Impression Comparison and Individualization, Forensic Correlation Between Tread Patterns and Ground Surfaces, Forensic Identification of Gait-Based Abnormalities in Impression Evidence, Three-Dimensional Reconstruction of Tool Marks and Footwear Impressions, Forensic Differentiation of Man-Made vs. Natural Impressions, Microstructural and Wear Analysis of Footwear Soles and Tire Treads, Forensic Examination of Layered Impressions and Overlapping Prints, Forensic Applications of Chemical and Elemental Analysis in Impression Evidence, Validation of Impression Evidence Through Experimental Forensic Studies.

Practice - To study forensic gait analysis through dynamic footprint impressions.

UNIT – IV: Legal, Quality Control, and Expert Testimony

Error Rate Estimation and Reliability Assessment in Impression Analysis, Forensic Validation and Standardization of Impression Analysis Techniques, Accreditation Standards for Impression Analysis (ISO, SWGTREAD, FBI, INTERPOL), Cognitive Bias and Examiner Decision-Making in Impression Comparison, Legal Challenges in Impression Evidence Admissibility, Expert Witness Preparation for High-Profile Impression Evidence Cases, Courtroom Dynamics and Advanced Cross-Examination Strategies for Impression Experts, Forensic Documentation and Automated Report Generation in Impression Evidence, Role of Forensic Impression Evidence in Cold Case Investigations, Admissibility Challenges in Forensic Impression Evidence Interpretation, Impact of Judicial Precedents on Impression Evidence Reliability, Forensic Quality Assurance Protocols in Impression Analysis.

Practice - To differentiate footwear impressions based on tread wear patterns.

UNIT – V: Forensic Techniques and Applications

Reconstruction of Partial and Distorted Impressions, Multi-Source Impression Analysis, Correlation of Impression Evidence with Trace Evidence, Pressure-Sensitive Materials in Forensic Analysis, Validation of Impressions Through Mechanical and Chemical Testing, Nanomaterials in Impression Preservation, Differentiation of Genuine vs. Artificial Impressions, Spectroscopic Techniques in Impression Examination, Integration of Impression Evidence with Fingerprints and Tool Marks, Environmental Effects on Impression Persistence, Crime Scene Movement Reconstruction, Tactile Impression Analysis in Forensic Anthropology.

Practice - To assess the reliability of forensic casting materials in three-dimensional impression preservation.

Textbooks:

1. Bodziak, W. J. (2017). *Forensic Footwear Evidence: Detection, Recovery and Examination*. CRC Press.
2. Cassidy, M. J. (2019). *Footwear and Tire Track Evidence*. CRC Press.

Reference Books:

1. Hammer, L. (2021). *Forensic Photography for Impression Evidence*. Springer.
2. Springer, E. (2010). *Advances in Fingerprint and Impression Evidence*. Elsevier.

Web Links:

1. https://www.nist.gov/forensic-science/latent-fingerprint-detection
2. https://www.fbi.gov/services/cjis/fingerprints-and-other-biometrics
3. https://www.interpol.int/en/Crimes/Forensics/Fingerprints
4. https://nij.ojp.gov/topics/articles/development-and-validation-latent-fingerprint-technologies
5. https://www.rcmp-grc.gc.ca/en/fingerprint-identification

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
MSC 4: Forensic Physics & Ballistics											
2511FS19	**III**	Advanced Firearm and Ammunition Analysis	AC	2		2	4	50	50	100	-
2511FS20		Advanced Forensic Wound Ballistics	AC	3		1	4	50	50	100	-
2511FS21		Computational and Experimental Ballistics	AC	2		2	4	50	50	100	-
2511FS22		Structural Failure Analysis and Forensic Engineering	AC	3		1	4	50	50	100	-
2511FS23		Forensic Audio Analysis	AC	2		2	4	50	50	100	-
2511FS24		Instrumental and Analytical Techniques in Forensic Physics & Ballistics	AC	3		1	4	50	50	100	-
Total				**15**		**9**	**24**				

MSC 4: Forensic Physics & Ballistics

Advanced Firearms and Ammunition Analysis

	L	T	P	C
Course Code: 2511FS19				
Semester -III	2	0	2	4

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the principles and mechanics of firearms and ammunition systems, including their design, innovations, and forensic significance.
CO2: Analyze and interpret microscopic and macroscopic marks on firearm and ammunition evidence, including specialty ammunition, rifling effects, and toolmark analysis.
CO3: Apply advanced analytical techniques such as computational fluid dynamics, high-speed videography, and AI-assisted trajectory prediction for the identification and comparison of ballistic evidence.
CO4: Reconstruct shooting incidents using forensic tools and methodologies, including 3D ballistic imaging, Doppler radar, and digital forensic applications.
CO5: Explore emerging technologies and their applications in firearms and ammunition analysis, including smart guns, electronic firing mechanisms, and advanced ballistic databases.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	1	2	2	-	2	-	-	-	1
CO2	1	2	-	3	3	-	2	-	-	-	1
CO3	2	3	-	3	2	2	2	1	-	-	1
CO4	2	2	1	2	2	1	2	1	-	-	1
CO5	2	2	-	2	2	2	2	1	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	1
CO3	2	2
CO4	3	2
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Firearms Mechanism and Design

Advanced Classification of Firearms and their Forensic Significance, Innovations in Firearm Manufacturing and their Forensic Implications, Design and Working Principles of Automatic and Semi-Automatic Weapons, Smart Guns and Electronic Firing Mechanisms, Suppressors, Silencers, and Muzzle Devices in Forensic Examination**.**

Practice - To understand the design, working principles, and classification of various firearms.

UNIT – II: Ammunition and Propellants

Specialty Ammunition: Armor-Piercing, Tracer, Incendiary, and Frangible Rounds, Chemical Composition and Forensic Identification of Modern Propellants, Ballistic Gel Analysis for Ammunition Testing, Reloaded and Counterfeit Ammunition Identification, Ammunition for Non-Lethal Weapons (Rubber Bullets, Bean Bag Rounds).

Practice - To analyse the chemical composition of propellants using forensic techniques.

UNIT – III: Internal Ballistics

Computational Fluid Dynamics in Internal Ballistics, High-Speed Videography for Combustion Analysis in Propellants, Barrel Rifling Effects on Bullet Stabilization, Advanced Recoil Compensation Techniques, Shockwave Dynamics in Firearm Discharge.

Practice - To conduct toolmark analysis on fired bullets and cartridges using stereo microscopy.

UNIT – IV: External Ballistics

AI-Assisted Trajectory Prediction Models, Supersonic vs. Subsonic Projectile Behavior, Effect of Atmospheric Variables (Temperature, Altitude, and Wind) on Bullet Flight, Radar and Doppler Analysis in External Ballistics, Computational Simulations of Projectile Motion.

Practice - To compare fired bullets and cartridge cases using a comparison microscope for forensic matching.

UNIT – V: Ballistics Testing and Instrumentation

3D Ballistic Imaging and Trajectory Mapping, Micro and Nano-Level Toolmark Analysis in Firearm Examination, High-Speed Doppler Radar Applications in Forensic Ballistics, Database Systems for Firearm and Ammunition Identification, Digital Forensic Applications in Firearm and Ammunition Tracking.

Practice - To explore the use of AI-assisted models, Doppler radar, and computational tools in trajectory analysis.

Textbooks:

1. Heard, B.J. Handbook of Firearms and Ballistics: Examining and Interpreting Forensic Evidence. Wiley.
2. Haag, L.C., & Haag, M.G. Shooting Incident Reconstruction. Academic Press.

Reference Books:

1. Di Maio, V.J.M. Gunshot Wounds: Practical Aspects of Firearms, Ballistics, and Forensic Techniques. CRC Press.
2. Davis, J.A. An Introduction to Forensic Firearm Examination. CRC Press.

Web Links:

1. https://nij.ojp.gov/topics/equipment-and-technology/ballistic-resistance-body-armor-nij-standard-010107
2. FirearmsID - The Forensic Science of Firearms
3. Forensic Firearms and Toolmark Examination - AAFS
4. Ballistics Research Laboratory - Army Research
5. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000016FS/P000693/M011475/ET/1516189066FSC_P6_M5_e-text.pdf

Advanced Forensic Wound Ballistics

L	T	P	C
3	0	1	4

Course Code: 2511FS20
Semester - III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the principles of wound formation, energy deposition, and shock wave effects in firearm injuries.

CO2: Apply advanced imaging techniques such as MRI, CT scans, and AI-assisted analysis for firearm wound examination.

CO3: Analyze the biomechanics of firearm injuries, including fracture mechanics, fluid dynamics, and penetration testing.

CO4: Evaluate ballistic trauma in forensic anthropology, distinguishing firearm injuries from other forms of trauma.

CO5: Demonstrate expertise in the forensic investigation of gunshot wounds, including legal considerations and case studies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	-	2	-	-	-	1
CO2	2	3	-	3	3	2	2	1	-	-	1
CO3	2	2	-	2	3	1	2	-	-	-	1
CO4	1	1	3	2	2	-	2	-	2	-	1
CO5	2	1	2	-	2	-	3	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	2
CO3	2	1
CO4	3	2
CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Advanced Terminal Ballistics and Wound Analysis

Hydrodynamic Theory of Wound Formation, Energy Deposition Models in Wound Ballistics, Advanced Tissue and Organ Damage Simulation, Shock Wave Effects in Firearm Injuries, Neurological and Vascular Implications of Gunshot Wounds.

Practice - To study neurological and vascular damage caused by gunshot wounds.

UNIT – II: Techniques in Wound Ballistics

Artificial Tissue Analogs for Forensic Testing, MRI and CT scans in Firearm Wound Analysis, AI-Assisted Wound Pattern Recognition, Advanced Methods for Differentiating Close-Range and Long-Range Wounds, Forensic Importance of Blood Spatter Analysis in Firearm Injuries.

Practice - To interpret gunshot wound characteristics through MRI and CT scan analysis.

UNIT – III: Firearm Injury Dynamics and Biomechanics

Forensic Biomechanics in Wound Ballistics, Fracture Mechanics in Gunshot Injuries, Fluid Dynamics in Blood Flow Post-Impact, Projectile Impact on Different Body Regions and Organs, Penetration Testing Using Ballistic Gelatin Alternatives.

Practice - To conduct penetration testing using ballistic gelatin and synthetic tissue alternatives.

UNIT – IV: Forensic Anthropology in Ballistic Trauma

Ballistic Trauma Analysis on Skeletal Remains, Differentiation Between Firearm Injuries and Blunt Force Trauma, Effects of Aging and Decomposition on Firearm Injury Assessment, Ballistic Injury Reconstruction from Partial Remains, and Forensic Odontology in Firearm-Related Head Injuries.

Practice - To differentiate firearm injuries from blunt force trauma using a comparison microscope.

UNIT – V: Investigative and Legal Aspects of Gunshot Wounds

Gunshot Wound Analysis in Mass Shooting Incidents, Cross-Examination of Forensic Wound Ballistics Evidence in Court, Ethical Considerations in Wound Ballistics Research, Role of Forensic Pathologists in Gunshot Investigations, Case Studies of Historical Forensic Wound Ballistics Investigations.

Practice - To analyse entry and exit wound morphology using a stereo microscope.

Textbooks:

1. Di Maio, V. J. M. (1985). *Gunshot wounds: Practical aspects of firearms, ballistics, and forensic techniques*. Elsevier.
2. Kneubuehl, B. P., Coupland, R. M., Rothschild, M. A., & Thali, M. J. (2011). *Wound ballistics*. Springer.

Reference:

1. Stephens, B. G. (2006). Practical pathology of gunshot wounds. *Archives of Pathology & Laboratory Medicine*, 130(9), 1283–1289. Meridian

2. Stevenson, T., Carr, D. J., Harrison, K., & Mahoney, P. F. (2020). Ballistic research techniques: Visualizing gunshot wounding patterns. *International Journal of Legal Medicine*, 134(3), 1103–1114. SpringerLink

Web Links:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9462949/
2. https://www.ajronline.org/doi/10.2214/ajr.155.4.2119095
3. https://archive.org/details/woundballisticsb0000coup
4. https://www.researchgate.net/publication/26238151_Historical_overview_of_wound_ballistic_research
5. https://www.amazon.com/Gunshot-Wounds-Ballistics-Techniques-Investigations-ebook/dp/B07VMC4WQK

Computational and Experimental Ballistics

	L	T	P	C
Course Code: 2511FS21				
Semester - III	2	0	2	4

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the principles of ballistics, including computational techniques and their role in forensic science.

CO2: Analyze firearm evidence using advanced forensic techniques such as toolmark analysis, GSR analysis, and high-speed imaging.

CO3: Apply wound ballistics concepts to assess injuries, interpret ballistic trauma, and understand projectile behavior in various environments.

CO4: Reconstruct firearm-related events using trajectory simulations, computational fluid dynamics, and forensic tools.

CO5: Explore modern technologies and emerging trends in forensic ballistics research, including hypervelocity projectiles, nanomaterials, and 3D printing applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	2	2	-	-	-	1
CO2	2	3	-	3	3	2	2	1	-	-	1
CO3	2	2	2	3	3	1	2	-	-	-	1
CO4	1	3	1	2	2	1	2	1	-	-	1
CO5	1	2	-	2	3	2	2	1	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	1
CO3	2	2
CO4	3	2
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Computational Techniques in Ballistics

Application of Machine Learning in Ballistic Trajectory Prediction, AI-Based Gunshot Event Reconstruction, Computational Fluid Dynamics in Firearm and Projectile Analysis, 3D Forensic Reconstruction of Shooting Incidents, Neural Networks for Firearm Fingerprinting.

Practice - To conduct a case study on the application of machine learning in ballistic trajectory prediction and its forensic implications.

UNIT – II: High-Speed Experimental Ballistics

Ultra-High-Speed Photography for Projectile Impact Studies, Schlieren Imaging in Shockwave Visualization, High-Speed Radiography in Firearm Discharge Analysis, Pressure Sensors for Internal Ballistic Measurements, Electromagnetic and Railgun Projectile Analysis.

Practice - To analyse a real-world case using ultra-high-speed photography to study projectile impacts and firearm discharge behaviour.

UNIT – III: Aero and Hydro Ballistics

Aerodynamic Properties of Projectiles in High-Speed Motion, Submerged Ballistics: Projectile Behavior in Water, Interaction of Bullets with Glass, Metal, and Composite Surfaces, Ballistic Gelatin Testing under Varying Environmental Conditions, Terminal Effects of Bullets in Non-Conventional Mediums (Water, Air, Tissue Simulants).

Practice - To investigate a case involving projectile interaction with different surfaces (glass, metal, composite) using forensic microscopy techniques.

UNIT – IV: Emerging Technologies in Ballistics

Hypervelocity Projectiles and Forensic Implications, Electromagnetic Ballistics Testing Techniques, Nanomaterials in Firearm Coatings and Forensic Implications, 3D-Printed Firearms and Ammunition: Forensic Challenges, Case Studies of Forensic Breakthroughs in Ballistics.

Practice - To conduct a case study on the forensic implications of 3D-printed firearms and ammunition, analysing the forensic challenges through advanced imaging.

UNIT – V: Instrumentation in Ballistics Research

X-Ray Diffraction and SEM Analysis in Ballistic Investigations, Forensic Applications of Raman and FTIR Spectroscopy in Bullet Residue Analysis, Digital Ballistic Fingerprinting Techniques, Ballistic Software Simulations and Crime Scene Reconstructions, Integration of GIS and Forensic Ballistics.

Practice - To analyze a case study on the forensic application of X-ray diffraction and SEM analysis in identifying ballistic residues from a crime scene.

Textbooks:

1. Carlucci, D. E., & Jacobson, S. S. (2013). *Ballistics: Theory and design of guns and ammunition* (2nd ed.). CRC Press.
2. DiMaio, V. J. M. (1999). *Gunshot wounds: Practical aspects of firearms, ballistics, and forensic techniques* (2nd ed.). CRC Press.

Reference:

1. Stephens, B. G. (2006). Practical pathology of gunshot wounds. *Archives of Pathology & Laboratory Medicine*, 130(9), 1283–1289.

2. Stevenson, T., Carr, D. J., Harrison, K., & Mahoney, P. F. (2020). Ballistic research techniques: Visualizing gunshot wounding patterns. *International Journal of Legal Medicine*, 134(3), 1103–1114.

Web Links:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9462949/
2. https://www.ajronline.org/doi/10.2214/ajr.155.4.2119095
3. https://archive.org/details/woundballisticsb0000coup
4. https://www.researchgate.net/publication/26238151_Historical_overview_of_wound_ballistic_research
5. https://www.amazon.com/Gunshot-Wounds-Ballistics-Techniques-Investigations-ebook/dp/B07VMC4WQK

Structural Failure Analysis and Forensic Engineering

L	T	P	C
3	0	1	4

Course Code: 2511FS22
Semester - III
Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the principles of forensic engineering and the role of physics in material failure investigations.

CO2: Analyze material failure mechanisms, including fractography, fatigue, and stress corrosion cracking, and apply advanced testing methods for failure analysis.

CO3: Evaluate the failure of civil engineering structures and apply computational techniques for structural analysis and collapse investigation.

CO4: Investigate vehicle failures, including tire and braking system failures, and reconstruct accident scenarios using forensic methods and data recorders.

CO5: Explore emerging trends and technologies in forensic engineering, such as smart sensors, blockchain, AI, and biomechanics, for structural health monitoring and failure analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1	1	2	2	1	2	-	-	-	1
CO2	2	3	-	3	3	2	2	-	-	-	1
CO3	2	2	-	3	2	1	2	-	-	-	1
CO4	2	3	1	2	3	1	2	-	-	-	1
CO5	1	2	-	2	3	2	2	1	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	1
CO3	2	2
CO4	3	1
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Concepts in Forensic Engineering

Failure Analysis Techniques in Forensic Engineering, Application of Physics in Material Failure Investigations, Case Studies of Catastrophic Engineering Failures, Role of Forensic Physics in Industrial Accident Investigations, Legal and Ethical Aspects of Forensic Engineering.

Practice - To conduct a case study on the failure analysis of a major industrial accident, focusing on the role of forensic physics and material failure investigation.

UNIT – II: Material Failure Analysis

Fractography and Microscopic Examination of Failure Surfaces, Analysis of Fatigue, Creep, and Stress Corrosion Cracking, Thermographic and Ultrasonic Methods for Structural Failure Detection, Nondestructive Testing Methods NDT in Forensic Engineering, Advanced Methodologies for Forensic Analysis of Electrical Failures.

Practice - To investigate a real-world case of fatigue or stress corrosion cracking in materials, using fractography and microscopic analysis of failure surfaces.

UNIT – III: Failure of Civil Engineering Structures

Dynamic Loads and Structural Instability in Forensic Cases, Failure Mechanisms in Reinforced Concrete, Steel, and Composite Structures, Collapse Analysis Using Finite Element Methods, Analysis of Failed Bridges, Dams, and Buildings, Case Studies of Historical Structural Failures.

Practice - To study the collapse of a bridge or building using finite element analysis, assessing failure mechanisms and dynamic loads.

UNIT – IV: Forensic Road Accident and Vehicle Failure Analysis

Fire Failure Analysis and Forensic Implications, Braking System Failure Investigations, Engine Performance Failure Analysis, Reconstruction of Accident-Induced Structural Failures, Forensic Role of Black Box and Event Data Recorders EDRs.

Practice - To analyze a case of tire failure and its role in a road accident, using forensic evidence to reconstruct the failure scenario.

UNIT – V: Emerging Trends in Forensic Engineering

Smart Sensors for Real-Time Structural Health Monitoring, Blockchain Technology in Forensic Engineering Data Security, AI and Robotics in Forensic Structural Inspections, Biomechanics in Forensic Engineering, Advanced Case Studies in Forensic Failure Analysis.

Practice - To conduct a case study on the use of smart sensors for real-time monitoring of structural health and its role in forensic investigations.

Textbooks:

1. Ratay, R. T. (Ed.). (2000). *Forensic Structural Engineering Handbook*. McGraw-Hill.
2. Gagg, C. R. (2020). *Forensic Engineering: The Art and Craft of a Failure Detective*. CRC Press.

Reference Books:

1. Yaxley, W. T., & Bracken, W. C. (2002). Forensic Engineering Structural Failure Review by Finite Element Analysis. *Journal of the National Academy of Forensic Engineers*, 19(1).
2. Fitzgerald, T. J. (2022). Metal Plate Connection Failures in Wood Trusses: Lessons Learned from Damage Investigations. In *Forensic Engineering 2022* (pp. 1081–1091). American Society of Civil Engineers. HYPERLINK "https://ascelibrary.org/doi/book/10.1061/9780784484548?utm_source=chatgpt.com"

Web Links:

1. https://www.structuremag.org/article/the-forensic-engineering-process-for-structural-failures/
2. https://www.envistaforensics.com/services/forensic-engineering/structural-failure/
3. https://www.jsheld.com/areas-of-expertise/technical-scientific/forensic-engineering/failure-collapse-analysis
4. https://www.sciencedirect.com/journal/engineering-failure-analysis
5. https://www.kimley-horn.com/services/forensics/structural-site-forensics

Forensic Audio Analysis

L	T	P	C
2	0	2	4

Course Code: 2511FS23

Semester -III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental principles of acoustics and their application in forensic investigations, including sound propagation, psychoacoustics, and signal analysis techniques.
CO2: Analyze and evaluate different audio recording technologies and forensic audio equipment, applying techniques for noise reduction, signal enhancement, and frequency analysis in criminal investigations.
CO3: Authenticate and verify the integrity of audio evidence using forensic techniques such as audio fingerprinting, speaker identification, and metadata analysis.
CO4: Apply advanced forensic audio techniques, including speech analysis, voice biometrics, and audio-video correlation, for identifying and profiling speakers and verifying the authenticity of audio recordings.
CO5: Understand the legal and ethical considerations in forensic audio analysis, including the standards for audio evidence in court, privacy concerns, and international protocols for audio investigations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	1	2	1	-	-	1
CO2	1	3	-	3	3	2	2	2	-	-	1
CO3	2	2	2	2	2	-	2	2	-	-	1
CO4	2	3	1	2	2	2	3	-	-	-	1
CO5	1	1	3	-	2	-	3	1	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	2
CO4	3	2
CO5	2	3

Unit-Wise Syllabus:

UNIT – I: - Fundamentals of Acoustics

Overview of Sound Waves: Longitudinal Waves, Frequency, Amplitude, Wavelength, the Speed of Sound, Factors Affecting Sound Transmission (Medium, Temperature, Etc.), Acoustic Properties of Materials: Reflection, Refraction, Diffraction, Absorption, Psychoacoustics: Human Perception of Sound, Auditory Masking, Sound Localization. Sound Propagation Open Confined Spaces, Impact Environmental Factors (E.G., Weather Conditions, Urban Settings) on Sound Quality, Acoustic Modeling Simulation for Crime Scene Audio Analysis, Noise Vs. Signal Analysis: Identifying Relevant Information Noisy Environments. Principles Impulse Sounds (Gunshots, Explosions, Etc.), Identifying Resonance Enclosed Spaces (E.G., Rooms, Vehicles), Fourier Transform Spectral Analysis for Forensic Audio Investigations.

Practice - To analyze a case study involving the propagation of a gunshot sound in an urban environment and how environmental factors (e.g., building structures, traffic noise) impact the sound quality.

UNIT – II: Audio Recording Technologies and Forensic Audio Equipment

Audio Recording Devices: Analog Vs. Digital Audio Recordings: Characteristics, Advantages, Limitations, Microphones: Types (Dynamic, Condenser, Electret) Their Forensic Applications, Recorders: Digital Audio Recorders, Tape Recorders, Their Signal Characteristics, Surveillance Systems: Digital Surveillance Devices, Body Cams, Cell Phone Recordings. Acoustic Analysis Tools: Audio Analysis Software: Spectral Analysis, Waveform Analysis, Time-Domain Analysis, Equipment Used for Forensic Audio Analysis (E.G., Sound Level Meters, Oscilloscopes, Signal Analyzers), Frequency Analysis: Identifying Specific Frequencies, Harmonics, Their Sources, Speech Recognition Systems Their Forensic Applications. Signal Processing Enhancement: Noise Reduction Algorithms: Removing Background Noise, Hiss, Distortion, Speech Enhancement Techniques: Filtering, Equalization, Dynamic Range Compression, Time-Stretching Pitch-Shifting to Isolate Important Audio Cues, Fourier Wavelet Transforms for Signal Separation.

Practice - To investigate a case study on the use of speech enhancement techniques (filtering and dynamic range compression) to improve the clarity of a distorted 911 emergency call recording.

UNIT – III: Speaker Identification

Definition and significance of speaker identification in forensic investigations. Role of speaker identification in criminal cases (e.g., phone threats, ransom calls, extortion). Overview of the human vocal system and speech production. Unique features of individual voices: pitch, tone, cadence, and timbre. Process of speaker identification in comparison to other forensic identification methods. Factors influencing vocal characteristics: age, gender, health, and emotional state. Digital Signal Processing (DSP), Feature Extraction Techniques, Spectrogram Analysis. Real-World Case Studies.

Practice - To examine a case study where audio splicing or alteration was detected in a digital recording, utilizing forensic tools to uncover the manipulation.

UNIT – IV: Forensic Techniques in Audio Analysis

Speech Linguistic Analysis: Forensic Phonetics: Analyzing Speech Patterns, Dialects, Accents, Speaker Profiling: Gender, Age, Emotional State Determination Through Speech, Linguistic Markers Voice Recordings: Detecting Stress, Speech Anomalies, Emotional Inflections, Language Forensics: Identifying Unusual Speech Patterns Criminal Cases. Voice Speech Identification: Acoustic Characteristics Speech: Pitch, Tone, Cadence, Rhythm, Their Forensic Implications, Forensic Voice Comparison: Identifying Verifying Voices Recorded Evidence, Voice Biometrics: Advances Speaker Recognition Technologies, Forensic Analysis Foreign Languages or Dialects Recordings. Audio Video Correlation: Synchronizing Audio Video Forensic Investigations: Determining the Authenticity Temporal Alignment, Identifying Discrepancies Between Audio Video Data (E.G., Lip-Sync, Background Noise), Multi-Modal Forensic Analysis: Combining Audio, Video, Environmental Data for Comprehensive Investigation, Use High-Speed Cameras to Capture Sound-Emitting Events.

Practice - To conduct a voice comparison case study, identifying the same speaker in two different recordings through acoustic characteristics like cadence and rhythm.

UNIT – V: Legal Ethical Aspects Forensic Audio Analysis

Legal Standards for Accepting Audio Evidence Criminal Trials: Certification Chain Custody Audio Recordings, Expert Witness Testimony Audio Analysis Cases, Case Studies Use Forensic Audio Evidence Court. Ethical Issues Audio Forensics: Privacy Concerns Audio Surveillance Recording, Ethical Considerations When Dealing With Sensitive Audio Evidence (E.G., Private Conversations, Confessions), Balancing Law Enforcement Needs With Civil Liberties Audio Surveillance, Issues Consent the Legality Recording Conversations. Global Standards Forensic Audio Analysis: International Protocols Best Practices Forensic Audio Investigations, Accreditation Certification Standards Forensic Audio Experts, Legal Frameworks for Audio Evidence Across Jurisdictions, Ethical Standards for Forensic Audio Research Professional Conduct.

Practice - To explore a case involving audio surveillance, discussing the balance between law enforcement needs and civil liberties, focusing on the ethical considerations of recording private conversations.

Textbooks:

1. Maher, R. C. (2018). *Principles of Forensic Audio Analysis*. Springer.

2. Koenig, B. E. (1990). *Spectrographic Voice Identification: A Forensic Survey*. Elsevier.

Reference:

1. Begault, D. R., Beck, S. D., & Maher, R. C. (2018). Forensic analysis of gunshot recordings. *Proceedings of Meetings on Acoustics*, 33(1), 1-9.

2. Fayyad-Kazan, H., & Fawaz, M. (2021). Verifying the audio evidence to assist forensic investigation. *Computer and Information Science*, 14(3), 25-35.

Weblink:

1. https://aes2.org/audio-topics/audio-forensics-2/
2. https://nij.ojp.gov/topics/articles/emerging-field-firearms-audio-forensics
3. https://www.sciencedirect.com/science/article/pii/S2665917423001964
4. https://en.wikipedia.org/wiki/Audio_forensics
5. https://en.wikipedia.org/wiki/Electrical_network_frequency_analysis

Instrumental and Analytical Techniques in Forensic Physics & Ballistics

L	T	P	C
3	0	1	4

Course Code: 2511FS24

Semester - III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the principles and applications of advanced microscopic techniques, including SEM, TEM, and X-ray microtomography, in forensic investigations.
CO2: Analyze forensic ballistic evidence using spectroscopic and chromatographic methods, including LIBS, HPLC, and isotopic ratio mass spectrometry.
CO3: Evaluate the applications of radiographic and imaging techniques, such as synchrotron radiation and terahertz imaging, in forensic ballistics and physical evidence analysis.
CO4: Apply data analytics, blockchain, and cloud-based databases to analyze ballistic evidence and enhance forensic ballistics informatics.
CO5: Explore emerging trends in forensic physics and ballistics, including nanotechnology, 4D printing, quantum physics, and AI-driven instrumentation, with a focus on ethical considerations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	3	2	2	2	-	-	-	1
CO2	2	3	-	2	3	2	2	1	-	-	1
CO3	2	2	1	2	3	1	2	1	-	-	1
CO4	2	2	-	3	2	2	1	2	-	-	1
CO5	2	1	3	2	2	3	2	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	3	1
CO3	2	2
CO4	2	2
CO5	3	3

Unit-Wise Syllabus:

UNIT – I: Microscopic Techniques

High-Resolution SEM and TEM in Forensic Investigations, X-Ray Microtomography for Forensic Applications, Microscopic Analysis of Gunshot Residues and Explosive Residues, Spectral Imaging for Forensic Ballistic Evidence, Emerging Trends in Forensic Microscopy.

Practice - To conduct a case study on the use of high-resolution SEM and TEM in the analysis of gunshot residues from a crime scene.

UNIT – II: Spectroscopic and Chromatographic Methods

LIBS Laser-Induced Breakdown Spectroscopy in Forensic Ballistics, High-Performance Liquid Chromatography HPLC in Propellant Analysis, Isotopic Ratio Mass Spectrometry in Forensic Firearms Analysis, Emerging Spectroscopic Methods for Forensic Physics Investigations, Case Studies on Forensic Spectroscopic Applications.

Practice - To conduct a case study on the use of LIBS (Laser-Induced Breakdown Spectroscopy) in the analysis of firearm residue and its forensic significance.

UNIT – III: Radiographic and Imaging Techniques

Industrial Radiography in Forensic Applications, Synchrotron Radiation and its Forensic Uses, Terahertz Imaging for Forensic Ballistic Evidence, Multispectral and Hyperspectral Imaging in Forensic Analysis, Emerging Forensic Radiographic Case Studies.

Practice - To study the use of industrial radiography in forensic applications for analyzing firearm projectiles and explosive materials in criminal investigations.

UNIT – IV: Data Analytics in Forensic Ballistics

Big Data Analytics for Ballistic Evidence, Blockchain-Based Forensic Data Security, Cloud-Based Forensic Ballistics Databases, Cybersecurity in Forensic Ballistics Databases, Case Studies on Forensic Ballistics Informatics.

Practice - To conduct a case study on the application of big data analytics in the analysis of ballistic evidence, focusing on crime scene reconstruction and database correlation.

UNIT – V: Future Trends in Forensic Physics and Ballistics

Emerging Nanotechnology Applications in Forensic Physics, 4D Printing and its Forensic Implications, Quantum Physics in Forensic Applications, AI-Driven Forensic Instrumentation, Ethical Considerations in Forensic Physics Research.

Practice - To investigate the application of emerging nanotechnology in forensic analysis, focusing on its potential to enhance firearm residue detection or ballistic analysis.

Textbooks:

1. Wolstenholme, R., & Bradshaw, R. (2016). *Analytical Techniques in Forensic Science*. Wiley.

2. Heard, B. J. (1997). *Handbook of Firearms and Ballistics: Examining and Interpreting Forensic Evidence*. Wiley.

Reference Books:

1. De Kinder, J., & Bonfanti, M. S. (1999). Automated comparisons of bullet striations based on 3D topography measurements. *Forensic Science International*, 101(2), 85–93.

2. Smith, E. L., & Hamby, J. E. (2002). The use of laser profilometry in firearm and toolmark identification. *Journal of Forensic Sciences*, 47(5), 945–953.

Weblink:

1. https://www.nist.gov/firearms-and-toolmarks
2. https://nij.ojp.gov/topics/articles/century-ballistics-comparison-giving-way-virtual-3d-methods
3. https://link.springer.com/book/10.1007/978-3-662-69237-0
4. https://www.sciencedirect.com/science/article/abs/pii/S1355030612001050
5. https://aboutforensics.co.uk/firearms-ballistics/

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
MSC 5: Digital Forensics											
2511FS25	III	Advanced Digital Forensics	AC	2		2	4	50	50	100	-
2511FS26		Cyber Law & Incident Response Management	AC	3		1	4	50	50	100	-
2511FS27		Cloud & IoT Forensics	AC	2		2	4	50	50	100	-
2511FS28		Mobile Forensics	AC	3		1	4	50	50	100	-
2511FS29		Network Forensics	AC	2		2	4	50	50	100	-
2511FS30		Reverse Engineering & Malware Analysis	AC	3		1	4	50	50	100	-
Total				**15**		**9**	**24**				

MSC 5: Digital Forensics

Advanced Digital Forensics

L	T	P	C
2	0	2	4

Course Code: 2511FS25

Semester - III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Develop a comprehensive understanding of digital forensic principles, methodologies, and investigative procedures.
CO2: Gain proficiency in forensic data acquisition, memory analysis, and advanced file system forensics.
CO3: Conduct forensic investigations on Windows, Linux, mobile devices, and cloud environments using industry-standard tools.
CO4: Analyze network traffic, detect cyber threats, and investigate security incidents with forensic techniques.
CO5: Apply legal and ethical frameworks in forensic investigations, ensuring proper evidence handling and reporting.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	2	2	3	-	-	1
CO2	2	2	-	3	3	2	2	3	-	-	1
CO3	2	3	-	2	2	2	2	2	-	-	1
CO4	2	2	1	2	2	2	2	2	-	-	1
CO5	1	1	2	-	2	-	3	2	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	3	1
CO3	2	1
CO4	3	2
CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Advanced Digital Evidence & Forensic Methodologies

Digital forensic principles, forensic readiness, chain of custody, digital evidence admissibility, disk imaging, live forensics, volatile and non-volatile data handling, forensic duplication of encrypted drives, metadata analysis, file carving, RAID reconstruction, SSD forensics, blockchain forensics, cryptocurrency forensics, anti-forensics techniques, data obfuscation, timestamp manipulation, encryption evasion, hash collisions, forensic examination of emerging technologies.

Practice - Windows Registry and Log Analysis – Extracting and analyzing forensic artifacts from Windows systems.

UNIT – II: Memory Forensics & Advanced Malware Analysis

Volatile memory acquisition, fmem, LiME, /proc/kcore, forensic analysis with Volatility and Rekall, process injection detection, DLL hijacking, kernel rootkits, sandboxing, malware behavior analysis, reverse engineering techniques, zero-day exploit detection, polymorphic and metamorphic malware, ransomware investigation, credential extraction from RAM, LSASS dump analysis, Pass-the-Hash attacks, Mimikatz forensic examination, rootkit detection, forensic approaches to APT identification.

Practice - Memory Forensics Using Volatility & Redline – Identifying malware and suspicious processes in RAM dumps.

UNIT – III: Windows & Linux Forensic Investigations

Windows registry forensics, NTFS artifacts, Master File Table (MFT), $UsnJrnl, Shellbags, jump lists, lnk files, volume shadow copy analysis, timeline reconstruction with log2timeline and Plaso, Windows event log forensics, startup file forensics, forensic examination of security logs, EXT4 file system recovery, inode and journal analysis, Linux malware analysis, ELF binaries,

SUID/SGID exploitation tracing, forensic detection of backdoors, unauthorized persistence mechanisms, and stealth attacks.

Practice - Imaging and analyzing NTFS, FAT, and Linux file systems using forensic tools.

UNIT – IV: Advanced Network & IoT Forensics

Packet capture analysis, deep packet inspection, encrypted traffic analysis, covert channel detection, intrusion detection and network forensics, botnet tracking, DDoS investigation, log correlation techniques, wireless forensics, WPA3 forensic analysis, MAC spoofing detection, IoT forensics, smart device data acquisition, MQTT and CoAP protocol analysis, forensic challenges in IoT ecosystems, SCADA and Industrial Control System (ICS) forensics, cyber-physical attack investigation.

Practice - Capturing and analyzing network packets to detect anomalies.

UNIT – V: Cloud & Virtualized Environment Forensics

Cloud forensic methodologies, forensic challenges in SaaS, PaaS, IaaS models, cloud storage forensics, forensic data acquisition from AWS, Azure, Google Cloud, cloud metadata analysis, forensic investigation of virtualized environments (VMware, Hyper-V, containerized infrastructures), cloud log analysis, forensic monitoring of API calls, cloud malware analysis, multi-tenancy risks, cloud data breaches, forensic approaches to cloud cybercrime investigations, blockchain-based forensic applications in cloud security.

Practice - Extracting and examining data from smartphones and cloud environments.

Practical Work:

1. Windows Registry and Log Analysis – Extracting and analyzing forensic artifacts from Windows systems.
2. Memory Forensics Using Volatility & Redline – Identifying malware and suspicious processes in RAM dumps.
3. Imaging and analyzing NTFS, FAT, and Linux file systems using forensic tools.
4. Capturing and analyzing network packets to detect anomalies.
5. Extracting and examining data from smartphones and cloud environments.

Text Books:

1. *Practical Mobile Forensics* – Heather Mahalik, Rohit Tamma, Satish Bommisetty
2. *Cloud Security and Privacy* – Tim Mather, Subra Kumaraswamy, Shahed Latif

Reference Books:

1. *Guide to Computer Forensics and Investigations* – Bill Nelson, Amelia Phillips, Christopher Steuart.
2. *Digital Forensics with Open Source Tools* – Cory Altheide, Harlan Carvey

Web Links:

1. https://web-app.usc.edu/ws/soc_archive/soc/syllabus/20141/31945.pdf
2. https://www.bfh.ch/dam/jcr:d2dfc57e-fd2d-4db4-8bb0-06cb11bfb77f/study-guide-cas-digital-forensics-cyber-investigation-advanced-bfh.pdf
3. https://www.researchgate.net/publication/323798367_Advances_in_Digital_Forensics_Frameworks_and_Tools_A_Comparative_Insight_and_Ranking
4. https://www.sans.org/cyber-security-courses/advanced-digital-forensics-incident-response-threat-hunting/
5. https://www.eccouncil.org/programs/computer-hacking-forensic-investigator-chfi/

Cyber Law and Incident Response Management (IRM)

L	T	P	C
3	0	1	4

Course Code: 2511FS26

Semester - III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Develop an in-depth understanding of cyber laws, regulations, and digital governance frameworks.
CO2: Gain expertise in intellectual property rights, cyber contracts, digital forensics, and data protection laws.
CO3: Learn methodologies for cyber risk assessment, threat classification, and security incident categorization.
CO4: Master the principles of incident response planning, forensic analysis, and cyber crisis management.
CO5: Understand the role of Incident Response Teams (IRT), their responsibilities, and best practices for handling cyber incidents.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	3	-	1	-	2	2	-	-	1
CO2	1	1	2	-	2	-	2	2	-	-	1
CO3	1	-	1	-	3	-	2	3	-	-	1
CO4	1	-	2	-	2	-	3	2	-	-	1
CO5	1	1	2	-	2	-	3	2	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	3
CO2	2	2
CO3	3	2
CO4	3	3
CO5	2	2

Unit-Wise Syllabus:

UNIT – I: Cyber Law and Legal Framework

Introduction to cyber law, fundamental legal principles, cyber jurisprudence, cyber jurisdiction and cross-border cybercrime challenges, IT Act 2000 and its amendments, cybercrime classification, electronic evidence admissibility, legal frameworks for digital transactions, cyber laws in EU, USA, Australia, and Britain, data protection laws including GDPR, CCPA, and PDPB, and the role of regulatory authorities in cybersecurity enforcement.

Practice - Reviewing and analyzing landmark cybercrime judgments.

UNIT – II: Intellectual Property Rights & Digital Copyrights

Understanding copyrights, trademarks, and patents in cyberspace, cyber laws governing intellectual property, domain name disputes and legal frameworks, digital rights management (DRM), software piracy, multimedia copyright issues, WIPO and international IP protection, legal aspects of cyber contracts, electronic signatures, authorship disputes, document forgery, cyber frauds, and identity theft regulations.

Practice - Forensic Investigation of Digital Copyright Violation – Multimedia piracy and software licensing violations.

UNIT – III: Cyber Incident Risk & Threat Assessment

Cyber incident statistics and case studies, types of cyber threats including phishing, ransomware, DDoS, APTs, and cyber espionage, principles of risk assessment and cyber threat intelligence, vulnerability assessment methodologies, security incident categorization (low, medium, high risk), the role of information warfare in cybercrime, social engineering tactics, and cyber threat modeling.

Practice - Cyber Risk Assessment and Threat Modeling – Identifying and mitigating potential cybersecurity threats.

UNIT – IV: Incident Response & Cyber Risk Management

Incident response frameworks (NIST, SANS, ISO 27035), cyber risk governance models, threat containment strategies, digital forensics for incident management, impact assessment methodologies, Security Operations Center (SOC) functions, disaster recovery planning (DRP), business continuity planning (BCP), cyber insurance policies, regulatory compliance in incident reporting, industry security standards (PCI-DSS, HIPAA, etc.), and breach notification procedures.

Practice - Handling and responding to a simulated ransomware attack.

UNIT – V: Incident Response Team & Security Operations

Roles and responsibilities of Incident Response Teams (IRT), SOC vs. CSIRT vs. CERT, security awareness and training programs, cyber crisis management strategies, forensic investigation methodologies, security auditing, penetration testing in risk management, ethical hacking for threat mitigation, legal requirements for cyber investigations, and best practices for incident documentation and reporting.

Practice - Investigating network security incidents through forensic techniques.

Textbooks:

1. *Information Security and Cyber Laws* – Sunit Belapure & Nina Godbole
2. *Cyber Law and E-Security* – Kavita Singh

Reference Books:

1. *Cyber Law: The Indian Perspective* – Pavan Duggal
2. *Cybersecurity Law* – Jeff Kosseff

Web Links:

1. https://infosecawareness.in/cyber-laws-of-india
2. https://nvlpubs.nist.gov/nistpubs/specialpublications/nist.sp.800-61r2.pdf
3. https://www.cisa.gov/sites/default/files/2024-08/Federal_Government_Cybersecurity_Incident_and_Vulnerability_Response_Playbooks_508C.pdf
4. https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-61r2.pdf
5. https://www.sans.org/cyber-security-courses/incident-response-team-management/

Cloud and IoT Forensics

L	T	P	C
2	0	2	4

Course Code: 2511FS27

Semester - III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Develop an in-depth understanding of forensic methodologies, challenges, and tools in cloud and IoT environments.
CO2: Acquire skills for forensic data acquisition, evidence preservation, and investigative techniques in cloud computing and IoT ecosystems.
CO3: Conduct forensic investigations related to cloud infrastructures and IoT devices, including smart home and industrial IoT applications.
CO4: Detect, analyze, and mitigate security threats and cyber incidents using forensic techniques in cloud and IoT domains.
CO5: Apply legal, regulatory, and ethical principles in cloud and IoT forensic investigations, ensuring compliance with digital evidence standards.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	2	2	3	-	-	1
CO2	1	2	-	3	3	2	2	2	-	-	1
CO3	2	3	-	2	2	1	2	3	-	-	1
CO4	2	2	1	2	2	2	1	2	-	-	1
CO5	1	1	2	-	1	-	2	2	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	2
CO3	3	2
CO4	2	2
CO5	2	3

Unit-Wise Syllabus:

UNIT – I: Cloud Forensic Principles and Architecture

Overview of cloud computing and forensic challenges, cloud service and deployment models (IaaS, PaaS, SaaS, public, private, hybrid, and community), shared responsibility model, principles of cloud forensics, forensic readiness, data acquisition methods in cloud environments, forensic logging and monitoring techniques, chain of custody in cloud investigations, jurisdictional challenges, and cross-border digital evidence handling.

Practice – Case studies involving forensic logging and monitoring techniques.

UNIT – II: Forensic Data Acquisition and Analysis in Cloud Environments

Methodologies for forensic investigations in cloud platforms, techniques for collecting and preserving volatile and non-volatile data, forensic imaging of cloud storage, live and dead forensic acquisition approaches, API-based data extraction, forensic analysis of virtual machines (VMs) and hypervisors, snapshot and memory dump analysis, investigation of forensic artifacts in cloud storage services (AWS, Azure, Google Cloud), metadata analysis, log collection and correlation, and challenges in cloud evidence authentication.

Practice – Data acquisition from live and dead machines.

UNIT – III: IoT Forensics and Device Data Analysis

Introduction to IoT ecosystems, forensic challenges in IoT investigations, IoT device architecture, communication protocols (MQTT, CoAP, HTTP, Zigbee, Bluetooth, NFC, RFID), forensic extraction and analysis of IoT logs, network traffic analysis, timestamp verification, forensic acquisition of smart home devices, automotive forensics, cloud-assisted IoT forensic methods, industrial IoT (IIoT) forensic challenges, and strategies for ensuring evidence integrity in IoT forensics.

Practice - Capturing and analyzing network traffic from IoT environments to identify anomalies.

UNIT – IV: Security Threats, Incident Detection, and Response in Cloud and IoT

Analysis of cloud security threats, including data breaches, insider threats, API vulnerabilities, malware, and ransomware, forensic techniques for detecting cloud-based cyberattacks, forensic preparedness in cloud infrastructures. Investigation of IoT security threats such as botnets, firmware vulnerabilities, unauthorized access, forensic detection of IoT-based DDoS attacks (e.g., Mirai botnet), forensic analysis of IoT malware, logging and monitoring of IoT security events, forensic response to IoT-related security incidents, and integration of threat intelligence for cloud and IoT forensic applications.

Practice - Forensic examination of virtual machines (VMs) and Docker containers in cloud infrastructures.

UNIT – V: Legal, Ethical, and Compliance Aspects of Cloud and IoT Forensics

Regulatory and compliance frameworks (GDPR, NIST, ISO 27017/27018, PCI-DSS, Cloud Security Alliance guidelines), legal considerations in cloud and IoT forensic investigations, admissibility of digital evidence in court, cloud service provider policies and forensic constraints, data privacy and protection in IoT forensics, ethical hacking and penetration testing for cloud and IoT environments, jurisdictional complexities in cloud investigations, forensic documentation and report writing best practices, and case study analyses of real-world cloud and IoT forensic investigations.

Practice - Simulating and responding to cyber threats in cloud environments.

Textbooks:

1. *Digital Forensics for Cloud Computing: A Virtualized Environment* – Darren Quick and Benjamin Martini
2. *Practical IoT Forensics* – Anchit Bijalwan and Anuj Kumar

Reference Books:

1. *Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance* – Tim Mather, Subra Kumaraswamy, and Shahed Latif
2. *Cloud Computing: Principles and Paradigms* – Rajkumar Buyya, James Broberg, and Andrzej Goscinski

Web Links:

1. https://pmc.ncbi.nlm.nih.gov/articles/PMC11359871/
2. https://scispace.com/pdf/digital-forensic-challenges-in-internet-of-things-iot-1zscj46w.pdf
3. https://cs-coe.iisc.ac.in/wp-content/uploads/2020/07/Cloud-forensics.pdf
4. https://www.researchgate.net/publication/366570127_IoT_with_Multimedia_Investigation_A_Secure_Process_of_Digital_Forensics_Chain-of-Custody_using_Blockchain_Hyperledger_Sawtooth
5. https://www.coursera.org/learn/cloud-security-basics

Mobile Forensics

L	T	P	C
3	0	1	4

Course Code: 2511FS28

Semester - III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand concept of Mobile and wearable device forensics.
CO2: Learn various Techniques in Mobile Forensics.
CO3: Understand the fundamentals of mobile device architecture.
CO4: Learn various Digital Forensics Techniques
CO5: Understand the various Extraction techniques

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	2	2	1	2	3	-	-	1
CO2	2	3	-	3	3	2	2	2	-	-	1
CO3	1	1	-	2	2	1	1	2	-	-	1
CO4	2	2	-	2	2	2	2	3	-	-	1
CO5	1	1	-	3	3	2	1	1	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	1
CO2	2	1
CO3	2	-
CO4	2	1
CO5	3	1

Unit-Wise Syllabus:

UNIT – I: Introduction to Android & Forensic Environment

Android Architecture: Linux Kernel and its role in Android security, Android Libraries and Dalvik Virtual Machine, Application Framework and Application Layer, Android Security Model (Sandboxing, SELinux, Permission Model)

Android Hardware & Core Components: Central Processing Unit (CPU), Baseband Processor, Memory, SD Card, Display and Battery Functionality in Android Devices

Android Boot Process: Execution of Boot ROM Code, Bootloader, Linux Kernel, Init Process, Zygote, Dalvik VM, System Server

Setting up an Android Forensic Environment: Configuring an Android Virtual Device (AVD), Connecting and Accessing a Physical Device from a Workstation, Identifying Compatible Cables, Installing Device Drivers, Gaining Access to the Android Device for Forensic Analysis.

Practice - Setting Up an Android Forensic Environment and Accessing an Android Device.

UNIT – II: Android OS Internals & Data Storage

Android Debug Bridge (ADB): Connecting to Devices using ADB, Detecting Connected Devices, Issuing Shell Commands, Installing and Removing Applications via ADB, Extracting and Pushing Data Using ADB, Viewing Logs and Debugging Android Devices

Understanding Rooting in Android: Rooting, Need of Rooting an Android Device, Recovery Mode and Fastboot Mode, Custom Recovery and Bootloader Lock/Unlock Mechanisms, Rooting a Locked and Unlocked Bootloader

Android Storage & File System Overview: Partition Layout (bootloader, boot, recovery, user data, system, cache, radio), Android File Hierarchy & Directory Structure (acct, cache, dalvik-cache, data, dev, mnt, proc, root, system), Common Android File systems (Flash Memory, Media-based, Pseudo file systems)

Application Data Storage: Shared Preferences and Internal Storage, External Storage & SD Card Usage, SQLite Databases and Network Storage

Practice - Logical Data Extraction from an Android Device Using ADB.

UNIT – III: Data Extraction in Android Devices

Mobile Forensics Approach & Challenges: Investigation Process: Preparation, Seizure, Acquisition, Examination, and Reporting, Common Challenges in Android Forensics

Logical Data Extraction: Extracting Data Logically using ADB Commands, Root Access & Manual ADB Data Extraction, USB Debugging & ADB Shell Techniques, Recovering Data via ADB Backup Extraction, Parsing ADB Backups (Apps, User Data, Logs), Extracting SIM Card Data (SIM Cloning, Security Considerations)

Physical Data Extraction: Extracting Data from Android Devices via Custom Bootloaders, Recovery Mode and Fastboot Mode-Based Acquisition, Verifying Root Access for Full Data Extraction.

Practice - Rooting an Android Device and Accessing Restricted Data

UNIT – IV: Logical & Physical Extraction Techniques

Physical Imaging of Android Devices: Extracting Full Device Image Using dd and nanddump, Writing Data to an SD Card for Analysis, Streaming Data to a Workstation via Netcat

RAM & SD Card Forensics: Imaging Android RAM Using LiME & Mem Extraction, Identifying Data Stored in RAM, Recovering Deleted Data from SD Cards

Advanced Data Recovery Techniques: Analyzing Physical Dumps for Hidden & Deleted Data, Recovering Deleted Data from Internal Memory, Parsing SQLite Database for Deleted Entries, File Carving Techniques for Data Reconstruction, Analyzing Android Device Backups for Evidence.

Practice - Physical Data Acquisition Using DD and Nanddump

UNIT – V: Android Application Forensics

Application Analysis in Forensics: Identifying Installed Applications & Extracting App Data, Understanding Time Formats (Linux Epoch, WebKit, Julian Date), Wi-Fi & Location Data Extraction

Forensic Analysis of Popular Apps: Contacts, Call Logs, SMS/MMS Data Analysis, Gmail, Chrome, Google Maps, Google Hangouts, Google Keep, Social Media & Messaging Apps: Facebook & Messenger Data Extraction, WhatsApp Backup Decryption & Message Recovery, Snapchat, Viber, Skype (Including Video Message Recovery).

Practice - Forensic Analysis of Android Applications and Recovery of Deleted Data.

Text Books:

1. Learning Android Forensics by Rohit Tamma, Donnie Tindall, Packt Publication (2015).
2. Practical Mobile Forensics, A Hands-on Guide to Mastering Mobile Forensics for the IOS, Android, and the Windows Phone Platforms, 3rd Edition by Heather

Reference Books:

1. Mobile Forensic Investigations: A Guide to Evidence Collection, Analysis, and Presentation, Second Edition by Lee Reiber, McGraw-Hill Education Publication (2018).
2. Android Hacker's Handbook by Joshua J. Drake, Zach Lanier, Georg Wicherski, Pau Oliva Fora, Stephen A. Ridley, Collin Mulliner, Wiley Publication (2014).

Web Links:

1. https://www.cadosecurity.com/wiki/mobile-forensics-guide-techniques-and-challenges
2. https://www.researchgate.net/publication/354970989_Mobile_device_forensics
3. https://nvlpubs.nist.gov/nistpubs/specialpublications/nist.sp.800-101r1.pdf
4. https://www.sans.org/cyber-security-courses/smartphone-forensic-analysis-in-depth/
5. https://www.cellebrite.com/en/mobile-forensics/

Network Forensics

L	T	P	C
2	0	2	4

Course Code: 2511FS29

Semester - III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand Network Forensic Fundamentals and techniques
CO2: Detect and Analyze Cyber Threats
CO3: Analyze Network Traffic and Intrusions
CO4: Investigate Intrusions and Malware Attacks
CO5: Apply Legal and Ethical Principles in Network Investigations

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	2	3	2	2	3	-	-	1
CO2	1	2	-	2	2	2	2	3	-	-	1
CO3	2	2	1	3	2	2	1	2	-	-	-
CO4	2	3	1	3	3	1	2	2	-	-	1
CO5	1	1	3	-	2	-	3	3	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	-
CO4	3	2
CO5	1	3

Unit-Wise Syllabus:

UNIT – I: Introduction to Network Forensics

Fundamentals of network forensics, importance and scope, digital evidence in network investigations, network attacks and forensic investigation methodologies. OSI and TCP/IP models, network protocols (HTTP, FTP, SMTP, DNS, DHCP, ICMP), packet structure, and network packet analysis. Network traffic capturing and analysis using tools like Wireshark, tcpdump, and Tshark

Practice -. Capturing and analyzing network traffic using Wireshark.

UNIT – II: Intrusion Detection and Incident Response

Network Intrusion Detection and Prevention Systems (NIDS/NIPS), signature-based vs. anomaly-based detection, deployment of IDS/IPS (Snort, Suricata). Firewall configurations, log analysis, log aggregation, and correlation. Incident response procedures, identifying security breaches, real-time threat hunting, and maintaining the chain of custody in network forensic investigations.

Practice - Investigating intrusions using Snort and Suricata IDS/IPS.

UNIT – III: Network Traffic Analysis and Malware Investigation

Network flow analysis using NetFlow and sFlow, detecting anomalies and suspicious network behavior. Investigation of malicious network activities such as DDoS attacks, ransomware, and Advanced Persistent Threats (APTs). Network-based malware analysis, botnet detection, and command & control (C2) communication analysis. Encrypted traffic analysis, SSL/TLS inspection, and deep packet analysis.

Practice - Analyzing firewall and router logs for forensic evidence.

UNIT – IV: Wireless and Cloud Forensics

Wireless network forensic techniques, Wi-Fi security threats (Evil Twin, deauthentication, WPA cracking), wireless packet capturing using Aircrack-ng and Kismet. VoIP forensics, packet interception, fraud detection, and forensic analysis of VoIP communications. Cloud forensic challenges, log analysis, metadata extraction, and forensic techniques for investigating cloud-based cyber threats.

Practice - Detecting and investigating malicious network traffic.

UNIT – V: Legal Aspects and Case Studies in Network Forensics

Legal and ethical considerations in network forensics, admissibility of network-based digital evidence, chain of custody, compliance with GDPR, ISO 27037, and NIST guidelines. Case studies on real-world network attacks, insider threats, and Advanced Persistent Threat (APT) investigations. Practical applications of forensic techniques in cybersecurity incident response and cybercrime investigations.

Practice - Wireless forensics: Capturing and analyzing Wi-Fi packets.

Reference Books:

1. *Network Forensics: Tracking Hackers through Cyberspace* – Sherri Davidoff, Jonathan Ham.
2. *Practical Packet Analysis* – Chris Sanders.

Text Books:

1. *The Practice of Network Security Monitoring* – Richard Bejtlich.
2. *Applied Network Security Monitoring* – Chris Sanders & Jason Smith.

Web Links:

1. https://www.eccouncil.org/cybersecurity-exchange/computer-forensics/what-is-network-forensics/
2. https://www.kentik.com/kentipedia/network-forensics/
3. https://www.cemca.org/ckfinder/userfiles/files/Module%207%20Network%20Forensics.pdf
4. https://www.sans.org/cyber-security-courses/network-forensics/
5. https://www.geeksforgeeks.org/network-forensics/

Reverse Engineering & Malware Analysis

L	T	P	C
3	0	1	4

Course Code: 2511FS30

Semester - III

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand Malware Classification and Behavior – Identify different types of malware (viruses, worms, Trojans, ransomware, rootkits) and analyze their behavior and attack vectors.
CO2: Perform Static and Dynamic Malware Analysis – Utilize reverse engineering techniques, disassemblers, debuggers, and sandboxing environments for malware investigation.
CO3: Analyze Malware Persistence Mechanisms – Study techniques such as process injection, DLL hijacking, and registry modifications used by malware for persistence.
CO4: Apply Forensic Techniques in Malware Investigation – Investigate malware artifacts, memory analysis, and network traffic analysis to detect and mitigate malicious activities.
CO5: Utilize Advanced Tools for Malware Detection and Prevention – Work with industry-standard tools such as IDA Pro, OllyDbg, Ghidra, Wireshark, and YARA for malware detection and signature creation.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	2	3	2	2	3	-		1
CO2	1	3	-	3	3	3	2	2	-	-	1
CO3	2	2	-	2	2	2	2	2	-	-	1
CO4	2	3	-	3	2	2	2	3	-	-	1
CO5	1	2	-	1	1	3	2	2	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	-
CO4	3	2
CO5	2	1

Unit-Wise Syllabus:

UNIT – I: Introduction to Reverse Engineering

Overview of x86 and x64 architectures, differences between source code and compiled code. Introduction to disassemblers (IDA Pro, Ghidra) and decompilers. Register set, data types, and function invocation. Self-defending malware and obfuscation techniques. Malicious documents and their analysis. Analysis of file formats such as PE, ELF, and PDF. Setting up a protected malware analysis lab using virtual machines and sandboxing.

Practice -. Static Malware Analysis – Perform PE file analysis, string extraction, and entropy analysis of packed malware samples.

UNIT – II: Reverse Engineering and Kernel Analysis

Kernel basics: processes, threads, ports, handles, services, and drivers. Windows Kernel API and scheduled tasks analysis. Kernel debugging with WinDBG. In-process dumping tools and imports rebuilding utilities. Rootkit techniques include hooking, patching, and kernel object manipulation. Anti-reversing techniques and piracy protection mechanisms. Deep web and dark web threats. JavaScript analysis complications in malware.

Practice -. Dynamic Malware Analysis – Execute malware in a controlled lab environment and monitor its system interactions.

UNIT – III: Static Malware Analysis

Database Security: Data Security, Database Security, Use and Importance of Database Security, Common Threats and Challenges, Software Vulnerabilities, Data Protection Tools and Platforms, Control Methods of Database Security.

Application Security: Loopholes of Application Security, Application Security Risks and Challenges.

Practice -. Reverse Engineering with IDA Pro – Disassemble and analyze a malware sample to understand its function calls.

UNIT – IV: Dynamic Malware Analysis

Executing malware in a safe environment. Monitoring processes using Process Monitor and Process Explorer. Registry change detection using RegShot. Simulating network traffic and sniffing packets with Wireshark. Rebuilding utilities and DLL analysis. Debugging malware using OllyDbg and IDA Pro. Browser script de-obfuscation and behavior analysis of remote access Trojans (RATs), botnets, and covert malware. Process injection techniques (APC injection, DLL injection). Memory forensics and detection of cryptographic algorithms in ransomware.

Practice -. Network Forensics and Malware Detection – Capture and analyze network traffic generated by malware using Wireshark.

UNIT – V: Malware Detection and Forensics

Advanced persistent threat (APT) analysis. Behavioral-based detection of malware. Signature-based and anomaly-based intrusion detection techniques. Network traffic analysis for malware communication detection. Automated malware analysis using artificial intelligence and machine learning. Case studies of modern malware attacks and forensic analysis of malware incidents. Tools and frameworks used in malware forensics: YARA rules, Cuckoo sandbox, and Volatility framework.

Practice -. Memory Forensics with Volatility – Extract and analyze malware artifacts from memory dumps.

Textbooks:

1. Michael Sikorski & Andrew Honig, *Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software*
2. Monnappa K. A., *Learning Malware Analysis: Explore the Concepts, Tools, and Techniques to Analyze and Investigate Malicious Software*

Reference Books:

1. *Chris Eagle, The IDA Pro Book: The Unofficial Guide to the World's Most Popular Disassembler*
2. *Bruce Dang, Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation*
3. *Reginald Wong, Mastering Reverse Engineering: Re-engineer your Ethical Hacking Skills*
4. *Tony Robinson, Operational Malware Analysis: Concepts and Case Studies*
5. *Joshua Saxe & Hillary Sanders, Malware Data Science: Attack Detection and Attribution*

Web Links:

1. https://malwareunicorn.org/
2. https://www.malwaretech.com/
3. https://virustotal.github.io/yara/
4. https://www.sans.org/digital-forensics
5. https://www.e-spincorp.com/malware-analysis-techniques/

M.Sc. Forensic Science and M.Sc. Cyber Security & Digital Forensics

Skill Enhancement Courses (SEC)

Course Code	Sem	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2511FS35	I	IT Skills	FC			2	2	50	50	100	-
2511FS36	II	Courtroom Testimony	FC	2			2	50	50	100	-
2511FS37	III	Research Methodology & Scientific Writing	FC	4			4	50	50	100	-
2511FS38	IV	Student Activity Based Learning	FC				2				-
Total				6		2	10				

IT Skills

(Common to both M.Sc. Forensic Science & M.Sc. Cyber security & Digital Forensics)

Course Code: 2511FS35

L	T	P	C
0	0	2	2

Semester -I

Course Outcomes:
At the end of the course, students will be able to:

CO1: Understand the role of computing and information technology in the digital world.
CO2: Identify, describe, and apply emerging technologies in teaching and learning environments.
CO3: Effectively apply written, oral, and interpersonal communication skills and use information technology.
CO4: Analyze organizational context, strategy, operations, processes, and performance.
CO5: Understand the importance of keeping safe online.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	1	1	1	1	-	-	2
CO2	1	1	-	-	2	3	2	2	-	-	3
CO3	1	-	-	-	1	1	3	1	-	-	2
CO4	2	1	-	-	3	2	2	1	-	-	2
CO5	-	-	2	-	1	1	1	2	-	-	3

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	1
CO4	3	-

CO5	1	3

Unit-Wise Syllabus:

UNIT - I: Advanced Computer & Office Automation

Computer Fundamentals: In-depth study of CPU architecture, memory management, and system performance optimization. Advanced Operating Systems: Multi-user OS, virtualization, file system management, and cloud computing integration. Office Automation: AI-driven automation, workflow optimization, and integration with cloud services (Google Drive, OneDrive). Cybersecurity in Office Systems: Data encryption, access control, and secure document handling.

Practice - Document Formatting & Structuring in Microsoft Word

UNIT II: Microsoft Word - Advanced Document Processing

Advanced Formatting & Structuring: Custom templates, multi-section formatting, indexing, and citations. Collaboration & Review: Track changes, comments, version history, and co-authoring in cloud environments. Macros & Automation: Automating repetitive tasks with macros and scripting for efficiency. Security & Legal Considerations: Document encryption, digital signatures, and access control.

Practice - Data Analysis & Visualization in Microsoft Excel

UNIT III: Microsoft Excel - Data Analytics & Automation

Data Analysis & Visualization: Advanced PivotTables, Power Query, and Power BI integration. Complex Formulas & Functions: Nested formulas, array formulas, and statistical functions. Automation & Scripting: VBA for automation, creating custom macros, and automating repetitive tasks. Big Data & Database Connectivity: Importing/exporting data from SQL, Access, and online sources.

Practice - Professional Presentation Design in Microsoft PowerPoint

UNIT IV: Microsoft PowerPoint - Professional Presentation & Multimedia Integration

Advanced Slide Design: Custom themes, dynamic transitions, and interactive elements. Multimedia & Interactivity: Embedding videos, hyperlinks, live polls, and audience engagement tools. AI-Enhanced Presentations: Smart suggestions, real-time transcription, and speech-to-text integration. Cloud & Collaboration: Co-authoring, real-time editing, and remote presentation

delivery.
Practice - Email & Calendar Management in Microsoft Outlook

UNIT V: Microsoft Outlook & Professional Communication

Email Automation & Management: Rules, filters, scheduled emails, and AI-based categorization. Task & Calendar Optimization: Recurring tasks, shared calendars, and integration with project management tools. CRM & Contact Management: Advanced contact grouping, mailing lists, and business communication strategies. Data Security & Compliance: Email encryption, phishing protection, and legal compliance for professional use.

Practice - Office Automation Integration & Workflow Optimization

Textbooks:

1. Digital Logic and Computer Design – M. Morris Mano
2. Digital Fundamentals – Thomas L. Floyd
3. Fundamentals of Digital Logic with Verilog Design – Stephen Brown & Zvonko Vranesic
4. Logic and Computer Design Fundamentals – M. Morris Mano, Charles R. Kime & Tom Martin
5. Fundamentals of Digital Logic and Microcomputer Design – M. Rafiquzzaman

Reference Books:

1. Digital Logic Design and Computer Organization – Nikrouz Faroughi
2. Fundamentals of Digital Logic with VHDL Design – Stephen Brown & Zvonko Vranesic
3. An Animated Introduction to Digital Logic Design – J. A. Anderson
4. Digital Design: With an Introduction to Verilog – M. Morris Mano & Michael D. Ciletti
5. Digital Design: Principles and Practices – John F. Wakerly

Web Links:

1. https://www.coursera.org/browse/information-technology
2. https://www.globalknowledge.com/us-en/training/course-catalog/
3. https://alison.com/courses/it
4. https://www.cbtnuggets.com/it-training
5. https://skillsbuild.org/learners

Courtroom Testimony

(Common to both M.Sc. Forensic Science & M.Sc. Cyber security & Digital Forensics)

Course Code: 2511FS36

L	T	P	C
2	0	0	2

Semester -II

Course Outcomes:
At the end of the course, students will be able to:

CO1: Compare/contrast evidence admissibility standards in federal and state courts.

CO2: Relate scientific evidence to other components of the criminal justice system.

CO3: Use key court rulings to discuss admissibility and presentation of scientific evidence.

CO4: Apply concepts and principles of scientific evidence admissibility to real world cases & explain the role expert testimony plays in criminal and civil cases.

CO5: Demonstrate the process of expert testimony, including qualification, direct- and cross-examination Discuss ethical considerations for expert witnesses.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	3	-	1	-	2	-	1	-	1
CO2	-	-	1	-	2	-	1	-	2	-	1
CO3	-	-	2	-	2	-	2	-	1	-	1
CO4	1	-	1	-	3	-	3	-	2	-	1
CO5	-	-	3	-	3	-	2	-	2	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	3
CO2	1	2
CO3	1	2
CO4	2	3
CO5	1	2

Unit-Wise Syllabus:

UNIT - I: Fundamentals of Expert Witness Testimony

Role and responsibilities of an expert witness, Legal framework: Rules of evidence and admissibility (Frye, Daubert standards), Voir dire: Qualification and disqualification of experts, Ethical considerations and professional conduct in testimony, Case studies on expert witness credibility.

UNIT - II: Preparation of Expert Witness Documents

Drafting an expert witness Curriculum Vitae (CV), Creating and structuring expert reports, Developing testimony question lists (voir dire, direct, and cross-examination, Handling conflicting evidence and maintaining objectivity, Practical exercise: Writing a CV and testimony question list.

UNIT - III: Courtroom Procedures and Mock Testimony

Structure of courtroom proceedings and legal terminology, Roles of the judge, jury, attorneys, and expert witnesses, Direct and cross-examination techniques, Handling aggressive questioning and maintaining composure, Practical exercise: Conducting a mock testimony session

UNIT - IV: Virtual and Simulated Trial Practice

Virtual court procedures and online legal platforms, Differences between virtual and in-person testimony, Conducting a mock trial: Opening statements, expert qualification, and testimony Evaluating testimonies: Peer review techniques and self-assessment, Practical exercise: Participating in a virtual mock trial

UNIT -V: Post-Testimony Analysis and Professional Development

Reviewing courtroom performance and feedback analysis, writing a reflection paper on courtroom experiences, identifying strengths and areas for improvement, Continuous learning: Attending legal workshops and expert witness training. Practical exercise: Writing a reflection paper on the mock trial experience.

Textbooks:

1. Faigman, D. L., Kaye, D. H., Saks, M. J., & Sanders, J. (2018). *Modern Scientific Evidence: The Law and Science of Expert Testimony*.
2. Risinger, D. M. (2019). *The New Wigmore: A Treatise on Evidence – Expert Evidence*.
3. Imwinkelried, E. J. (2020). *The Methods of Attacking Scientific Evidence*.
4. Tiersma, P. M., & Solan, L. M. (2018). *The Oxford Handbook of Language and Law*.
5. Melendez-Diaz, A. (2021). *Forensic Evidence and the Law: Cases, Readings, and Materials*.

Reference Books:

1. Saks, M. J., & Faigman, D. L. (2022). *Expert Evidence and Scientific Proof in the Courtroom*.
2. Schumann, A. D. (2017). *Testifying in Court: A Guide for Expert Witnesses*

Web Links:

1. National Institute of Justice (NIJ): www.nij.gov
2. Federal Judicial Center: www.fjc.gov
3. American Academy of Forensic Sciences (AAFS): www.aafs.org
4. Daubert Tracker (Legal Expert Testimony Database): www.dauberttracker.com
5. Expert Witness Training Online: www.seak.com

Research Methodology & Scientific Writing

(Common to both M.Sc. Forensic Science & M.Sc. Cyber security & Digital Forensics)

Course Code: 2511FS37

Semester III

L	T	P	C
4	0	0	4

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamental principles of research methodology, including the meaning, objectives, and types of research.

CO2: Learn the process of identifying a research problem, formulating hypotheses, and designing research studies.

CO3: Explore various research methods, experimental designs, and data collection techniques used in scientific investigations.

CO4: Apply statistical and sampling techniques for effective data analysis and interpretation in research.

CO5: Develop scientific writing skills for preparing research reports, abstracts, and proposals for academic and professional use.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	1	2	-	-	-	-	-	-
CO2	1	1	-	2	3	-	-	-	-	1	-
CO3	2	1	-	2	3	-	-	-	1	1	-
CO4	2	-	-	3	2	-	-	-	-	-	-
CO5	-	-	-	-	2	-	3	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	2	1
CO3	2	-
CO4	3	1
CO5	2	1

Unit-Wise Syllabus:

Unit-I: Introduction to Research Methodology

Introduction to Research, Meaning of Research, Definition, Characteristics and Functions, Objectives, Classification and Kinds of Research, Research Problem, Introduction to Research Problems, Selecting and Defining the Research Problem, Sources of Research Problems, Criteria for Selection the Problem, Delimiting a Problem, Assumptions about a Problem, Evaluating the Problem.

Unit -II: Hypothesis Formulation & Research Design

Meaning and Definitions of Hypothesis, Assumptions, Postulates, Functions, Importance, Kinds, Characteristics of a Good Hypothesis, Variables in a Hypothesis, Sources of Hypothesis, Testing of Hypothesis, Research Plan and Design, Meaning and Definition of Research Design, Types and Characteristics of Research Design, Sampling, Meaning and Definition of Sampling, Functions of Population and Sampling, Types of Sampling Designs, Characteristics of a Good Sample, Application of Sampling Technique in Various Types of Research.

Unit- III: Types of Research & Experimental Design

Survey Research, Historical Research, Philosophical Research, Experimental Research, Case Study Research, Genetic Research, Need and Purpose of Experimental Design, Importance, Characteristics of Good Experimental Design, Basic Principles of Experimental Design, and Types of Basic Experimental Design.

Unit -IV: Research Tools & Data Collection

Questionnaire, Schedule, Rating Scale, Tests, Achievement Tests, Aptitude Tests, Psychological Tests, Meaning and Importance of Data Collection, Nature of Data, Qualitative vs. Quantitative Data, Constants, Variables, Variates, Characteristics of Quantitative Data, Types of Data, Primary Data, Secondary Data, Methods of Data Collection, Interviews, Observations, Surveys, Experiments, Organization and Classification of Data.

Unit-V: Scientific Writing & Research Report Preparation

Research Report Writing, Need, Importance, Format, Preliminary Section, Main Section, Reference Section, Mechanics of Report Writing, Scientific Writing, Writing Research Abstracts, Writing Research Papers, Purpose, Structure, Submission Process, Research Proposal Writing, Need, Structure, Writing for Dissertations, Ph.D., and Preparing Proposals for Research Funding.

Textbooks

1. Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International.
2. Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage publications.

References

1. Babbie, E. (2020). *The practice of social research* (15th ed.). Cengage Learning.
2. Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.

Web Links

1. https://www.scribbr.com/methodology/
2. https://www.researchgate.net/publication/Research_Methodology
3. https://www.sagepub.com/en-us/nam/research-methods
4. https://www.sciencedirect.com/topics/social-sciences/research-methodology
5. https://www.elsevier.com/authors/tools-and-resources/researcher-academy