DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/PG/College./NEP/19/2024

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies/ Ad-hoc Boards & recommended by the Dean, Faculty of Science & Technology, **Academic Council at its meeting held on 08 April 2024 has accepted** the following Syllabi under the Faculty of Science & Technology **as per Norms of National Education Policy -2020** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1.	M.Sc.Microbiology	IIIrd & IVth semester
2.	M.Sc.Botany	IIIrd & IVth semester
3.	M.Sc.Environmental Science	IIIrd & IVth semester
4.	M.Sc.Industrial Chemistry	IIIrd & IVth semester
5.	M.Sc.Biochemistry	IIIrd & IVth semester
6.	M.Sc.Chemistry Specialization Analytical Chemistry,Organic Chemistry, Inorganic Chemistry,Polymer Chemistry, Industrial Chemistry.	IIIrd & IVth semester
7.	MCA(Science)	IIIrd & IVth semester
8.	M.Sc (Forensic Science)	Ist to IVth semester
9.	M.Sc.Forensic Cyber	Ist to IVth semester

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Chhatrapati Sambhajinagar.
431 004.
REF.No.SU/2024/2446-54
Date:- 21.06.2024

* * * * *

Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,

2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

2] The Section Officer,[M.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Parikaha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada Univeraity, Chhatrapati Sambhajinagar.

Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRAPATI SAMBHAJINAGAR

NAAC Reaccredited with 'A' Grade

Faculty of Science and Technology

2 Years P.G. Programme in Science (M.Sc.)

Subject: Forensic Science

Revised Course Structure and Curriculum for Affiliated Colleges
(Outcome-Based Credit System)

As per National Education Policy 2020
(Effective from Academic Year -2024-25)

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Preamble

Forensic Science is in a true sense a multidisciplinary science, wherein various disciplines of science, humanities, health sciences, engineering, and commerce are applied to the investigation of crime. Dr. Babasaheb Ambedkar Marathwada University, Aurangabad is committed to providing a comprehensive syllabus for PG programs in Forensic Science in line with the objectives and philosophies of National Education Policy 2020. However, as Forensic Science is a diverse field, specialization is the need of hour to excel the students in their area of interest. Thus, like most Indian Universities, the provision of specialization has been explored and accommodated as per the requirements of NEP 2020.

Course Structure

The Course Structure as per the Government Resolution of the Department of Higher and Technical Education, Government of Maharashtra Dated 16/05/2023 is as follows:

Credits Distribution Structure for Two Years/One Year PG Program with Multiple Entry & Exit Options

Faculty of Science & Technology

Year / level	Sem.	Major subject		RM	OJT /FP	RP	Credits	Degree
		DSC Core Mandatory	DSE (Elective)					
First year 6.0	I	3(4) +2=14	4	4			22	PG Diploma (After 3 years degree)
	II	3(4) +2=14	4		4 Complete during summer break		22	
Cum. Cr. For PG Diploma		28	08	4	4		44	
Exit option with Post-graduate Diploma (44 credits) after the first year or two semesters with completion of courses equivalent to 44 credits								
Second Year 6.5	III	3(4) +2= 14	4			4	22	PG Degree after 3 years UG or PG Degree after 4 years UG
	IV	3(4) =12	4			6	22	
Cum. Cr. For 1 year PG Degree		26	8			10	44	
Cum. Cr. For 2 years PG Degree		54	16	4	4	10	88	
2 Years -4 sem.PG Degree (88 credits) after three-year UG Degree or 1 Year -2 sem. PG Degree (44 credits) after four-year UG degree								

Abbreviations

Major: A course, which should compulsorily be studied by the student as a requirement of core or major subject is termed as a core course.

DSE: Generally, a course that can be chosen from a pool of courses that may be very specific or specialized or advanced, or supportive to the discipline/subject of study or which provides an extended scope or which enables exposure to some other discipline/subject/domain or nurtures the candidates' proficiency/skill is called as an elective course.

OJT: On-Job Training: Internship/Apprenticeship

FP: Field Project

RP: Research Project

Vision

The vision of the curriculum is as follows:

- To produce graduates with the highest skill and professional ethics competitive to the global forensic demands.

Mission

The mission of the curriculum is as follows:

- To facilitate the updated domain knowledge and skills at par with the global forensic scenario
- To inculcate professional ethics, teamwork, leadership, and value system among students
- To provide research skills among students for further learning and finding innovative solutions

Program Educational Objectives

The educational objective of the PG program in Forensic Science is as follows:

- **PEO1:** To develop scientific and technical competency among graduates leading to a successful career in forensic sciences and allied disciplines
- **PEO2:** To develop analytical and problem-solving skills among students to solve complex issues/problems related to forensic analysis in crime investigation

- **PEO3:** To inculcate professionalism, ethics, teamwork, communication, and leadership quality in the students
- **PEO4:** To make the students responsive toward the environment and society
- **PEO5:** To inculcate the practices of lifelong learning in the direction to have a successful career and responsive citizen of the globe

Program Outcomes and Program-Specific Outcomes

The university is committed to implementing a student-centric curriculum throughout its programs. Program outcomes, program-specific outcomes, and course outcomes have been defined as per Bloom's taxonomy. These are as follows:

Program Outcomes (POs): Program outcomes describe what skills, knowledge, and behaviors students acquire as they progress through the program. The program outcomes are as follows:

PO1: Basic and Discipline-specific knowledge: Apply the knowledge of basic and applied sciences, engineering, social sciences, and arts to various forensic problems.

PO2: Problem Analysis: Identify and analyze forensic problems using standard methods based on a scientific approach.

PO3: Modern tool usage: Understand, select, and apply appropriate techniques, resources, and modern scientific techniques with an understanding of their merits and limitations.

PO4: Design/ Develop research-based solutions: Design novel solutions for regular or complex problems based on research outcomes.

PO5: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of forensic practices.

PO6: Effective Communication: Speak, read, write, and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media, and technology.

PO7: Forensic practices for society and criminal Justice setup: Understand and analyse the impact of forensic solutions on society and criminal justice setup.

PO8: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in a multidisciplinary setting.

PO9: lifelong learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of Technological change.

Program-Specific Outcomes (PSOs): Program Specific Outcomes are statements that describe what the graduates of a specific program should be able to do. The PSOs of the PG Program in Forensic Science are as follows:

- **PSO1:** Understand the basic and advanced techniques in various disciplines of forensic science.
- **PSO2:** Analyze the forensic samples using basic and state-of-the-art techniques of various disciplines of forensic science.
- **PSO3:** Evaluate the results of various techniques and make decisions on simple or complex forensic problems.
- **PSO4:** Design and develop research-based solutions to complex forensic problems.

Eligibility

A candidate who has passed B.Sc. (three-year program) in Forensic Science as a major from a recognized university with 45% marks will be eligible for getting admission to the first year of PG programs. Moreover, students who have completed at least 80 credits in Forensic Science will also be eligible to get admission to the first year of the PG program. Reservation policy and relaxation of marks will be as per the norms of the university and Government of Maharashtra.

Duration

As per the guidelines of the Government of Maharashtra and the university, the PG Program will be of two-year duration. However, the students need to pass the minimum credits within four years from the date of admission. Re-entry to the program, if left in between, can be made within five years. Lateral entry and exit will be as per the guidelines issued by the university from time to time.

Medium of Instruction

Presently, the medium of instruction is English. However, any change in this will be as per the guidelines of the university and the government of Maharashtra.

Attendance

Students must have a minimum of 75 % attendance in each theory and practical course to appear in the Semester End Examination (SEE), otherwise he/she will not be strictly allowed to appear for the SEE. However, students having 65 % attendance may request the Head of the concerned Institution for the condonation of attendance on medical grounds.

Assessment Scheme/Scheme of Examination

The assessment scheme is as follows:

- Continuous Internal assessment (CIA) will be for 40% while Semester End Examination (SEE) will be for 60%.
- It shall be mandatory for the students to pass individually for both SEE and CIA for each course to complete the program successfully.
- Passing percentage for both theory and practical shall be 40%.
- The CIA may be in terms of class tests, group, and individual assignments, and presentation.
- Changes in the examination scheme are possible as per the guidelines issued by the university from time to time.

Electives and Specialization

Looking into the multidisciplinary nature of forensic science, like most of Indian universities, five specializations (special papers) have been identified, namely, Questioned Documents, Fingerprints, and Biometrics, Forensic Chemistry and Toxicology, Forensic Biology, Serology and DNA Fingerprinting, Forensic Physics and Ballistics, Digital & Cyber Forensics and IT security. The number of specializations (special papers) offered by an affiliated Institute/college will be their sole right based on the available infrastructure and choice of the students of that institute/college. The specialization will be offered from the second year (third semester) onwards; however, the students are advised to select DSE in semesters I and II, keeping the specialization they would like to opt for in the second year in mind. The Institute/College should run the specialization/DSE for at least with 5 students. However, based on the choice of student and importance of elective, the Institute/college can run the elective/specialization with less than 5 students honoring the spirit of NEP 2020. The decision of the Director/Principal of the Institute/college in this regard shall be final.

Curriculum and Structure as per NEP 2020

As per the Government Resolution of the Department of Higher and Technical Education, Government of Maharashtra, the course structure of the PG program in Forensic Science is as follows:

Structure and Curriculum for Semester-I

Credit distribution and structure of two years/one-year program in Forensic Science with multiple entry and exit options

M.Sc. First Year (First Semester)

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credit Assigned		Total credits
			Th	Pr	Th	Pr	
Major Mandatory DSC	FOR/MJ/500T	Advanced Forensic Science-I	3	-	3	-	14
	FOR/MJ/501T	Advanced Forensic Science-II	3		3	-	
	FOR/MJ/502T	Advanced Forensic Science-III	3	-	3	-	
	FOR/MJ/500P	Practical based on FOR/MJ/500T	-	2	-	1	
	FOR/MJ/501P	Practical based on FOR/MJ/501T	-	2	-	1	
	FOR/MJ/502P	Practical based on FOR/MJ/502T	-	2	-	1	
	FOR/MJ/503	Skill/Practical based activity-I	-	4	-	2	
DSE (Choose anyone from the five courses: Theory and Practical together makes a complete course)	FOR/DSE/504T	Mathematical Physics	3	-	3	-	4
	FOR/DSE/504P	Practical based on FOR/MJ/504T	-	2	-	1	
	FOR/DSE/505T	Python Programming	3	-	3	-	
	FOR/DSE/505P	Practical based on FOR/MJ/505T	-	2	-	1	
	FOR/DSE/506T	Biochemistry	3	-	3	-	
	FOR/DSE/506P	Practical based on FOR/MJ/506T	-	2	-	1	
	FOR/DSE/507T	Inorganic Chemistry	3	-	3	-	
	FOR/DSE/507P	Practical based on FOR/MJ/507T	-	2	-	1	
	FOR/DSE/508T	Insurance Forensics-I	3	-	3	-	
	FOR/DSE/508P	Practical based on FOR/MJ/508T	-	2	-	1	
RM	FOR/RM/509	Research Methodology and Statistics	4	-	4	-	4
			16	12	16	06	22

Structure and Curriculum for Semester-II

M.Sc. First Year (Second Semester)

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credit Assigned		Total credits
			Th	Pr	Th	Pr	
Major Mandatory DSC	FOR/MJ/550T	Advanced Forensic Science-IV	3	-	3	-	14
	FOR/MJ/551T	Advanced Forensic Science-V	3	-	3	-	
	FOR/MJ/552T	Advanced Forensic Science-VI	3	-	3	-	
	FOR/MJ/550P	Practical based on FOR/MJ/550T	-	2	-	1	
	FOR/MJ/551P	Practical based on FOR/MJ/551T	-	2	-	1	
	FOR/MJ/552P	Practical based on FOR/MJ/552T	-	2	-	1	
	FOR/MJ/553	Skill/Practical based activity-II	-	4	-	2	
DSE (Choose anyone from the five courses: Theory and Practical together make a complete course)	FOR/DSE/554T	Material Science and Forensic Engineering	3	-	3	-	4
	FOR/DSE/554P	Practical based on FOR/MJ/554T	-	2	-	1	
	FOR/DSE/555T	File Systems	3	-	3	-	
	FOR/DSE/555P	Practical based on FOR/MJ/555T	-	2	-	1	
	FOR/DSE/556T	Genetics and Bioinformatics	3	-	3	-	
	FOR/DSE/556P	Practical based on FOR/MJ/556T	-	2	-	1	
	FOR/DSE/557T	Organic Chemistry	3	-	3	-	
	FOR/DSE/557P	Practical based on FOR/MJ/557T	-	2	-	1	
	FOR/DSE/558T	Insurance Forensics-II	3	-	3	-	
	FOR/DSE/558P	Practical based on FOR/MJ/558T	-	2	-	1	
OJT/FP	FOR/OJT/599	OJT/FP	-	8	-	4	4
			12	20	12	10	22

Structure and Curriculum for Semester-III

M.Sc. Second Year (Third Semester)

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credit Assigned		Total credits
			Th	Pr	Th	Pr	
Major Mandatory DSC	FOR/MJ/600T	Special Paper-I	3	-	3	-	14
	FOR/MJ/601T	Special Paper-II	3	-	3	-	
	FOR/MJ/602T	Special Paper-III	3	-	3	-	
	FOR/MJ/600P	Practical based on FOR/MJ/600T	-	2	-	1	
	FOR/MJ/601P	Practical based on FOR/MJ/601T	-	2	-	1	
	FOR/MJ/602P	Practical based on FOR/MJ/602T	-	2	-	1	
	FOR/MJ/603P	Skill/Practical based activity-III	-	4	-	2	
DSE (Choose anyone from the courses: Theory and Practical together make a complete course)	FOR/DSE/604T	Physical Evidences	3	-	3	-	4
	FOR/DSE/604P	Practical based on FOR/MJ/604T	-	2	-	1	
	FOR/DSE/605T	Digital Image Processing	3	-	3	-	
	FOR/DSE/605P	Practical based on FOR/MJ/605T	-	2	-	1	
	FOR/DSE/606T	Immunology and Advanced Immunotechniques	3	-	3	-	
	FOR/DSE/606P	Practical based on FOR/MJ/606T	-	2	-	1	
	FOR/DSE/607T	Analytical Chemistry	3	-	3	-	
	FOR/DSE/607P	Practical based on FOR/MJ/607T	-	2	-	1	
	FOR/DSE/608T	Microscopy and Photography	3	-	3	-	
	FOR/DSE/608P	Practical based on FOR/MJ/608T	-	2	-	1	
	FOR/DSE/609T	Forensic Psychology and Criminology	3	-	3	-	
	FOR/DSE/609P	Practical based on FOR/MJ/609T	-	2	-	1	
RP	FOR/RP/649	Research Project-I	-	8	-	4	4
			12	**20**	**12**	**10**	**22**

Structure and Curriculum for Semester-IV

M.Sc. Second Year (Fourth Semester)

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./week)		Credit Assigned		Total credits
			Th	Pr	Th	Pr	
Major Mandatory DSC	FOR/MJ/650T	Special Paper-IV	3	-	3	-	12
	FOR/MJ/651T	Special Paper-V	3	-	3	-	
	FOR/MJ/652T	Special Paper-VI	3	-	3	-	
	FOR/MJ/650P	Practical based on FOR/MJ/650T	-	2	-	1	
	FOR/MJ/651P	Practical based on FOR/MJ/651T	-	2	-	1	
	FOR/MJ/652P	Practical based on FOR/MJ/652T	-	2	-	1	
DSE (Choose anyone from the courses: Theory and Practical together make a complete course)	FOR/DSE/653T	Appliances and Equipment Failure	3	-	3	-	4
	FOR/DSE/653P	Practical based on FOR/MJ/653T	-	2	-	1	
	FOR/DSE/654T	Web Application Penetration testing	3	-	3	-	
	FOR/DSE/654P	Practical based on FOR/MJ/654T	-	2	-	1	
	FOR/DSE/655T	Genetic Engineering	3	-	3	-	
	FOR/DSE/655P	Practical based on FOR/MJ/655T	-	2	-	1	
	FOR/DSE/656T	Physical Chemistry	3	-	3	-	
	FOR/DSE/656P	Practical based on FOR/MJ/656T	-	2	-	1	
	FOR/DSE/657T	Forensic Speaker Identification	3	-	3	-	
	FOR/DSE/657P	Practical based on FOR/MJ/657T	-	2	-	1	
	FOR/DSE/658T	Forensic Psychology and Legal Framework					
	FOR/DSE/658P	Practical based on FOR/MJ/658T					
RP	FOR/RP/699	Research Project-II	-	12	-	6	6
			12	**20**	**12**	**10**	**22**

Semester-I

Detailed Curriculum of Semester-I

Discipline-Specific Core Courses

FOR/MJ/500T	Advanced Forensic Science-I	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers basic concepts of forensic science, various physical evidence, and the criminal justice system. It also covers crime scene investigation and reconstruction.

Course Objectives

The course has the following objectives:

- Students will gain an idea of forensic science and its applications
- Students will learn and analyze the various crime scenes for their reconstruction
- Students will have an understanding of various physical evidence
- Students will understand various bloodstain patterns
- Students will learn the court and court procedures

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain forensic science, the criminal justice system, crime scene, physical evidence, and related concepts.
- CO2: Apply various scientific techniques in crime scene investigation
- CO3: Analyze various physical evidence and its involvement in crime
- CO4: Compare properties of various physical evidence
- CO5: Reconstruct the crime scene based on available evidence

Unit	Course Content	Contact Hours
Unit-I	**Introduction to Forensic Science** • Forensic Science and its significance • Criminal Justice system and its component • Courts and their power • Expert and its provisions in Indian Law • Court procedure for expert testimony	09
Unit-II	**Crime Scene Investigation and Management** • Introduction and types of crime scene • Steps for investigation of crime • Crime Scene Management • Preservation of crime scene • Documentation of Crime Scene • Collection, packing, and forwarding of evidence	09
Unit-III	**Physical Evidence**	09

	• Physical evidence and its types • Glass: types and composition, fracture pattern, forensic examination of glass • Paint: types and composition, forensic examination of paint • Soil: classification and composition, forensic examination of soil • Restoration of erased number: principle, techniques of alteration, and restoration	
Unit-IV	**Impression evidence** • Footprint/Shoeprint: Collection and lifting, comparison, gait pattern • Tire marks: types, collection, lifting and preservation, forensic examination • Tool marks: types, collection, lifting, and preservation and forensic examination	**09**
Unit-V	**Bloodstain Pattern and Crime Scene Reconstruction** • Bloodstain Pattern: Historical perspective, physical and biological properties of human blood, classification: spatter and non-spatter, droplet directionality and angle of impact, determination of Point of convergence and point of origin, altered bloodstain patterns • Crime Scene reconstruction (CSR): nature and importance of CSR, basic principles and stages. Case study for CSR.	**09**

Suggested Readings/Reference Books:

1. Richard Saferstien, Forensic Science: From the Crime Scene to the Crime Lab, 4th edition, Pearson, USA.
2. Suzane Bell, Forensic Science: An Introduction to Scientific and Investigative Techniques, Fifth Edition, CRC Press.
3. Henry C Lee, Crime Scene Handbook, Academic Press
4. Ross M. Gadner and Tom Bevel, Practical Crime Scene Analysis and Reconstruction
5. Max M. Houck and Jay A. Siegel, Fundamental of Forensic Science
6. Jaqueline T fish, Larry S. Miller, Crime Scene Investigation
7. Barry A J Fisher, David R. Fisher, Technique of crime scene investigation
8. Tom Bevel, Ross Gardner, Bloodstain pattern analysis with an introduction to crime scene reconstruction. Third edition.
9. Richard Saferstein, Handbook of Forensic Science, Volume-I, II and III
10. Brain Caddy, Forensic Examination of Glass and Paint: Analysis and Interpretation, CRC Press, 2001
11. Kenneth Pye, Geological and Soil Evidence: Forensic Applications, CRC Press, 2007.

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FOR/MJ/500P	Practical based on FOR/MJ/500T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Advanced Forensic Science-I** (FOR/MJ/500T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practicals has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To perform crime scene photography/videography
2. To perform crime scene sketching/note making
3. To collect various evidences from the scene of the crime
4. To investigate/reconstruct the given mock crime scenes
5. To examine given glass pieces for its (dis)similarity (color/opacity/refractive indices/density etc.)
6. To examine given soil samples for (dis) similarity (color, ignition, density gradient, weight loss etc.)
7. To restore erased numbers from different vehicles/articles/firearms
8. Physical and chemical examination of given paint samples
9. Study footprints/tyre marks on various surfaces
10. Study tool marks on various surfaces
11. Classify various blood stains
12. Determination of angle of impact from blood droplets
13. Determination of point of origin and area of convergence from the given blood spatters
14. Study the effect of dropping distance/surface texture on bloodstain pattern
15. Any other practical designed by the faculty member based on recent advances/latest trends

***

FOR/MJ/501T	Advanced Forensic Science-II	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers basic concepts of document forensics, fingerprint forensics, and ballistics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of document forensics, fingerprints, and ballistics
- Students will learn and analyze various documents, fingerprints
- Students will have an understanding of firearms and ammunition
- Students will develop latent fingerprints from various surfaces
- Students will learn to analyze fake/counterfeit documents

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain concepts of document forensics, fingerprints, and ballistics
- CO2: Apply various methods for the examination of questioned documents and fingerprints
- CO3: Analyze fraudulent documents
- CO4: Compare properties of firearms and ammunition
- CO5: Develop latent fingerprints from various surfaces

Unit	Course Content	Contact Hours
Unit-I	**Document Forensics-I** • Document forensics: Introduction and scope • Preliminary examination of documents • Handwriting/signature Identification: Principles and characteristics • Methods for collection of standards of handwriting/signature • Forgeries, their types, and their detection • Laws related to document examination	09
Unit-II	**Document Forensics-II** • Alteration in documents and their examination: addition, erasure, obliteration, overwriting • Decipherment of secret writing, indented writing, and charred documents • Examination of counterfeit currency, passport, visa, credit, and debit cards • Examination of rubber stamps, seals, and other mechanical impressions • Examination of printers and printed/photocopied documents	09

	• Examination of ink and paper	
Unit-III	**Fingerprint Forensics** • Introduction and scientific basis for fingerprint examination • Classifications of fingerprints • Various factors influencing the development of fingerprint • Sweat glands, the composition of sweat, and its role in fingerprint development • Development of latent prints: Physical and chemical methods • Fingerprint comparison and identification • Introduction to Automated Fingerpeint Identification System	**09**
Unit-IV	**Forensic Ballistics-I** • Introduction to ballistics and its importance in crime investigation • Types of ballistics • Firearms: Brief history, types of weapons, and their mechanism • Ammunition: Brief history, Types of ammunition, nomenclature, percussion caps, and their types, various priming composition, propellants, types of cartridge cases, their heads, various types of bullets, and their compositional aspects.	**09**
Unit-V	**Forensic Ballistics-II** • Estimation of range of firing: burning, blackening, tattooing, the spread of pellets, Walker's test. • Chemical tests of copper and lead around gunshot holes. • Gun-Shot Residue Analysis: Mechanism, lifting techniques, dermal nitrate, and instrumental techniques for analysis	**09**

Suggested Readings/Reference Books:

1. Hatcher, Jury and Weller, Firearm Investigation, Identification and Evidence, Stackpole Books
2. Brain J Heard, Handbook of Firearms and Ballistics, John Willey.
3. Hawthorne, Mark R., Fingerprints: analysis and understanding, CRC Press, 2009.
4. Henry C. Lee and R.E. Gaensslen, Advances in fingerprint technology, Second Edition, CRC Press, 2001.
5. Marzena Mulawka, Postmortem Fingerprinting, and Unidentified Human Remains, Elsevier, 2014.
6. Christophe Champod, Chris Lennard, Pierre Margot, And Milutin Stoilovic,

Fingerprints, and Other Ridge Skin Impressions, CRC Press, 2004.
7. Eric H. Holder, Jr., Laurie O. Robinson, and John H. Laub, The Fingerprint Sourcebook, US Department of Justice, 2009.
8. Jan Seaman Kelly and Brian S. Lindblom, Scientific examination of questioned documents, Taylor and Francis, 2006
9. Roy A. Huber and A.M. Headrick, Handwriting Identification: facts and fundamentals, CRC Press, 1999.
10. A. S. Osborn, Questioned Documents, 6th Edition, Law and Justice Publishing Company, 2020
11. Wilson R. Harrison, Suspect Documents Their Scientific Examination, 5th Edition, Universal Law Publishing, 2011.
12. Ellen, David, The scientific examination of documents: methods and techniques, 3rd Edition, CRC Press, 2005
13. Jane A. Lewis, Forensic Document Examination, Elsevier, 2014

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FOR/MJ/501P	Practical based on FOR/MJ/501T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Advanced Forensic Science-II** (FOR/MJ/501T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Recording of fingerprint
2. Identification of Fingerprint patterns
3. Determination of Ridge counting/tracing in a given fingerprint
4. Comparison of fingerprints using various methods
5. Classification of given fingerprints using Henry-FBI classification
6. Classification of fingerprints using a single digit classification
7. Development of latent prints using powder method
8. Development of latent prints using physical methods
9. Development of fingerprint using chemical methods
10. Development of submerged fingerprints
11. Study extent of natural variations in the handwriting samples
12. Compare two sets of handwriting samples for their origin
13. Compare two sets of signature samples for their origin
14. Detection and decipherment of invisible writing/charred documents
15. Detection and decipherment of alterations in documents/printed documents
16. Study the firing mechanism of various firearms
17. Study bullets/pellets of the given firearms
18. Study firing range from the given ammunitions/firearms
19. Analysis of gunshot residue
20. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/502T	Advanced Forensic Science-III	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the instrumental methods used in forensic examination. It covers a wide topic of spectroscopy, chromatography, microscopy, and bio-analytical techniques.

Course Objectives

The course has the following objectives:

- Students will gain an idea of instrumental methods and their applications in forensics
- Students will learn and analyze various samples through instruments
- Students will have an understanding of various components of spectrophotometers
- Students will understand various components of microscopes
- Students will learn various applications of the microscope in forensics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain basic concepts of spectroscopy, chromatography, and microscopy
- CO2: Apply instrumental techniques in diverse forensic scenarios
- CO3: Analyze samples using various instrumental techniques
- CO4: Compare properties of various samples using instrumental techniques
- CO5: Develop a new method for unknown sample

Unit	Course Content	Contact Hours
Unit-I	**Spectroscopy-I** • Electromagnetic radiation (EMR) • Wave and quantum properties of EMR • Atomic and Molecular spectra • UV-Visible Spectroscopy: Principle, instrumentation, and forensic applications • IR-Spectroscopy: Principle, instrumentation, and forensic applications • Raman Spectroscopy: Principle, instrumentation, and forensic applications	09
Unit-II	**Spectroscopy-II** • Mass Spectroscopy: Principle, instrumentation, and forensic applications • Atomic Absorption Spectroscopy: Principle, instrumentation and forensic applications • Atomic Emission Spectroscopy: Principle, instrumentation and forensic applications • X-Ray: principle, instrumentation, and applications of XRF and XRD	09

Unit-III	**Chromatography** • Introduction to chromatography and principle of separation: adsorption, partition, ion exchange, size-exclusion • TLC: principle, method, and forensic applications • HPTLC: principle, instrumentation, and forensic applications • HPLC: principle, instrumentation, and forensic applications • GC: principle, instrumentation, and forensic applications • Hyphenated Techniques: LC-MS, GC-MS	**09**
Unit-IV	**Bioanalytical techniques** • pH and buffers, physiological solutions • Centrifugation techniques: the basic principle of sedimentation, various types of centrifuges, density gradient centrifugation, preparative centrifugation, analysis of sub-cellular fractions, ultra-centrifuge-refrigerated centrifuges • Electrophoresis: principle, types, instrumentation, and applications • Immunoassay techniques	**09**
Unit-V	**Microscopy** • Basic concepts of microscopy • Simple and compound microscope • Comparison and Stereo microscope • Polarizing microscope, phase contrast microscope, and fluorescence microscope • Scanning electron microscope, and transmission electron microscope	**09**

Suggested Readings/Reference Books:

1. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, Cengage Learning
2. Hobart H. Willard, Lynne Lionel Merritt, John Aurie Dean, Frank A. Settle, Instrumental Methods of Analysis, CBS Publishers.
3. Suzanne Bell and Keith Morris, An Introduction to Microscopy, CRC Press
4. Abhilasha Shourie, Bioanalytical Techniques, The Energy and Resources Institute

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FOR/MJ/502P	Practical based on FOR/MJ/502T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Advanced Forensic Science-III** (FOR/MJ/502T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Estimation of pH of a given solvent/solution
2. Examination of chemicals/drugs/ink/paint using TLC
3. Examination of chemicals/drugs/ink/paint using UV-visible spectrophotometer
4. Examination of chemicals/drugs/ink/paint using FT-IR spectrophotometer
5. Examination of chemicals/drugs using Gas Chromatography
6. Examination of chemicals/drugs/ink/paint using HPLC
7. Examination of chemicals/drugs/ink/paint using HPTLC
8. Examination of chemicals/drugs/pigments using AAS
9. Examination of chemicals/drugs/pigments using XRF
10. Microscopic examination of soil
11. Microscopic examination of hair/fiber
12. Microscopic examination of paint
13. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/503	Skill/Practical-Based Activity-I	Credit:02	Contact Hours:60	Marks:50

Course Overview

The course has been designed to let the students acquire skills in his/her area of interest. As the aim of the course is to develop skills, the students can choose any one group of activities, which can be conducted under the guidance of a teacher. At the end, the student has to prepare a report on the skill acquired listing the practical work carried out throughout the semester.

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/503A	Skill based on Forensic Physics -I	02	60	50
		OR			
2	FOR/MJ/503B	Skill based on Digital Forensics-I	02	60	50
		OR			
3	FOR/MJ/503C	Skill based on Forensic Biology-I	02	60	50
		OR			
4	FOR/MJ/503D	Skill based on Forensic Chemistry-I	02	60	50
		OR			
5	FOR/MJ/503E	Skill based on Questioned Document, Fingerprint, and Biometrics-I	02	60	50

FOR/MJ/503A	Skill based on Forensic Physics-I	Credit:02	Contact Hours:60	Marks:50

List of activities

- Use mathematical models in various forensic problems
- Any other problem identified by the students

OR

FOR/MJ/503B	Skill based on Digital Forensics-I	Credit:02	Contact Hours:60	Marks:50

List of activities

- Solving forensic problems using Python programming
- Any other problem identified by the students

OR

FOR/MJ/503C	**Skill based on Forensic Biology-I**	**Credit:02**	**Contact Hours:60**	**Marks:50**

List of activities

- Analysis of biomolecules
- Any other problem identified by the students

OR

FOR/MJ/503D	**Skill based on Forensic Chemistry-I**	**Credit:02**	**Contact Hours:60**	**Marks:50**

List of activities

- Inorganic analysis of an unknown material
- Any other problem identified by the students

OR

FOR/MJ/503E	**Skill based on Questioned Documents, Fingerprints, and Biometrics-I**	**Credit:02**	**Contact Hours:60**	**Marks:50**

List of activities

- Authorship of an unknown document
- Development of latent print on challenging surfaces
- Any other problem identified by the students

Discipline Specific Elective Courses

FOR/DSE/504T	Mathematical Physics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the mathematical physics that can be used in forensic examination. It is covering wide topics of mathematical physics and its applications in diverse fields of forensic science.

Course Objectives

The course has the following objectives:

- Students will gain an idea of mathematical physics and their applications in forensics
- Students will learn and apply mathematical models in forensic science
- Students will have an understanding of concepts of differential equations, integral calculus, and graph theory
- Students will learn various applications of the mathematical functions in forensics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain differential equations, calculus and graph theory
- CO2: Apply mathematical equations and models in diverse forensic scenarios
- CO3: Correlate various forensic problems using mathematical equations
- CO4: Compare various forensic scenario mathematically
- CO5: Develop a new model for a forensic problem

Unit	Course Content	Contact Hours
Unit-I	**Mechanics** • Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body • Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work, and potential energy. • Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve) • Newton's Laws of Motion • Simple harmonic motion, Simple Pendulum, Projectile Motion.	09

Unit-II	**Differential Equations and Mathematical models** • General, particular, explicit, implicit, and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equations and Bernoulli equations, special integrating factors and transformations. • Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting. • The general solution of the homogeneous equation of second order, the principle of superposition for homogeneous equation, • Wronskian, its properties and applications. Linear homogeneous and non-homogeneous equations of higher order with constant coefficients. Euler's equation, method of undetermined coefficients, method of variation of parameters. Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.	09
Unit-III	**Calculus** • **Integral Calculus-** Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations. Areas and lengths of curves in the plane, volumes and	09

	surfaces of solids of revolution. Double and Triple integrals. • **Vector Calculus-** Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. Gradient, divergence and curl. • **Matrices-** Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four. Matrices in diagonal form. Reduction to diagonal form up to matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of a matrix. Solutions of a system of linear equations using matrices.	
Unit-IV	**Mathematical Functions in Forensic Science** • Mathematical Functions – Algebraic Functions, Polynomial Functions, Quadratic Functions • Logarithmic Functions – Origin and Definition, Exponential Functions – Origin and Definition • Applications – pH Scale, Forensic Pharmacokinetics; • Trigonometric Functions: Trigonometric functions and rules in Forensic Science, • Applications – Ricochet Analysis, Suicide, accident or murder, Bloodstain pattern and shape analysis, Aspects of Ballistics	**09**
Unit-V	**Graph Theory in Forensics** • Hyper Graph Theory: Representation of data using a graph, Linearizing equations, Construction and Calibration of graphs, Application – Shotgun pellet patterns in firearm incidents, Bloodstain formation,	**09**

	Determining time since death, Determining age from bone or tooth material.	

Suggested Readings/Reference Books:

1. A.S. Ramsay, Statics, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, Statics and Dynamics with Background in Mathematics, Cambridge University Press, 2003.
3. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005. 2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd., 2002
4. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.
5. A.I. Kostrikin, Introduction to Algebra, Springer Verlag, 1984.
6. S. H. Friedberg, A. L. Insel and L. E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
7. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.
8. Craig Adam; "Mathematics and Statistics for Forensic Science", Wiley Blackwell, 2010.
9. C.G.G. Aitkens and D. A. Stoney; "The Use of Statistics in Forensic Science", Ellis Harwood Limited, England 2011.
10. F. Taroni, S. Bozza, A. Biedermann, P. Garbolino; "Data analysis in Forensic Science", Wiley, 2010.
11. David Lucy; "Introduction to Statistics for Forensic Scientists", John Wiley & Sons Ltd., London, 2005.
12. C.G.G Aitkens and Franco Taroni; "Statistics and Evaluation of Evidence for Forensic Scientists", 2nd Edition, John Wiley & Sons, 2004.

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FOR/DSE/504P	**Practical based on FOR/DSE/504T**	**Credit:01**	**Contact Hours:30**	**Marks:50**

Course Overview

This is a laboratory course based on **Mathematical Physics** (FOR/DSE/504T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
10. Battle model (basic battle model, jungle warfare, long range weapons).
11. Plotting of recursive sequences.
12. Study the convergence of sequences through plotting.
13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequence from the plot.
14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
15. Cauchy's root test by plotting nth roots.
16. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/505T	Python Programming	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of Python programming. The course also covers direct applications of Python programming in forensics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of Python programming
- Students will learn and apply Python programming for many mathematical and logical problems
- Students will have an understanding of concepts of object-oriented programming using Python
- Students will learn various applications of Python in forensics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of Python programming
- CO2: Apply Python Programming on various mathematical and logical problems
- CO3: Illustrate Python Programming for forensic purposes
- CO4: Compare various forensic scenario through Python programming
- CO5: Develop a Python framework for a forensic problem

Unit	Course Content	Contact Hours
Unit-I	**Introduction to python programming** • Python Features, History, Installation Procedure, variable, Keywords, Comments, Literals Data types, Operators, Math Functions • Conditional Statements: If Statements, If-else Statements, Nested if-else Statements • Looping: For Loop, While, Nested loops, Control Statement, Break, Continue, Pass Exercises	09
Unit-II	**String, List and Dictionaries** • Strings: Accessing strings, Basic operations, String slices, Functions and methods. • Lists: Basics, List indexing and splitting, Updating List values, List Operations, iterating a List, adding	09

	elements to the list, Removing elements from the list, Built-in functions, and List methods. • Tuple: Creating a tuple, Tuple indexing and slicing, Negative Indexing, Deleting Tuple, Basic Tuple operations, Tuple inbuilt functions, List vs. Tuple • Set: Creating a set, adding items to the set, Removing items from the set • Dictionaries: Basics, working with dictionaries, accessing values in dictionaries, Counting words. • Function: Writing functions in Python, Introduction, defining a function, Calling function, Types of functions, Function Arguments, Anonymous functions, Global and local variables.	
Unit-III	**File Handling** • File Objects, File Built-in Functions, File Built-in Methods, File Built-in Attributes, Standard Files, Command-Line Arguments, File System, File Execution, opening a file, Writing the file, Read Lines of the file, creating a new file, File Pointer positions, modifying file pointer positions module, Creating the new directory, The directory, The () method, Changing the current working directory, Deleting directory.	**09**
Unit-IV	**Object Oriented Programming** • Introduction, class and object, Attributes, Inheritance, Overloading, Overriding, Abstraction, Data hiding, Processing files	**09**
Unit-V	**Python Forensics** • Why Python Forensics, Introduction, Cybercrime Investigation Challenges, setting up a Python Forensics Environment, Forensic Searching and Indexing Using Python, Forensic Evidence Extraction (JPEG and TIFF), Forensic Time, Using Natural Language Tools in Forensics.	**09**

Suggested Readings/Reference Books:

1. Python Forensics A Workbench for Inventing and Sharing Digital Forensic Technology, Gary C. Kessler
2. Beginning Python Using Python 2.6 and Python 3.1, James Payne.
3. Beginning Python From Novice to Professional, 2nd Edition, Magnus Lie Hetland
4. Core Python Programming (2nd Edition)

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FOR/DSE/505P	Practical based on FOR/DSE/505T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Python Programming** (FOR/DSE/505T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Installing python
2. Write a program in Python to display "Hello World" string on screen
3. Demonstration of constant and variables in python
4. Demonstration of operators in python
5. Demonstration of conditional statements in python
6. Demonstration of looping in python (for, while, nested)
7. Function in python
8. Working with lists in python
9. Working with strings in python
10. Working with dictionaries in python
11. Working with files in python
12. Python programming using object-oriented concepts.
13. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/506T	Biochemistry	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the basic concepts of Biochemistry, including the metabolic processes of carbohydrates, proteins, lipids, and nucleotides.

Course Objectives

The course has the following objectives:

- Students will gain the concepts of catabolism and anabolism, and the mechanics involved in these reactions
- Students will learn an overview of different pathways of carbohydrate metabolism
- Students will have an understanding of the formation and fate of amino acids, proteins, and nucleotides in the body
- Students will understand the biosynthesis and regulation of lipid molecules in the body

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of Biochemistry
- CO2: Apply various techniques for the estimation of biomolecules
- CO3: Analysis of biomolecules qualitatively and quantitatively
- CO4: Compare various biomolecules
- CO5: Develop a forensic framework for metabolism

Unit	Course Content	Contact Hours
Unit-I	**Metabolism** • Basic concepts of Metabolism: Concept of catabolism and anabolism: metabolic strategies, organization, clustering of enzymes. Thermodynamics, Regulation of Metabolic Pathways: energy change, phosphorylation potential, etc. Vitamins: Types, deficiencies.	09
Unit-II	**Carbohydrate metabolism** • Dark reactions of Photosynthesis: CO2 fixation: C3, C4 and CAM pathways. Cyclic overview and reactions. Glycolysis, pentose phosphate pathway, Krebs cycle, Electron transport chain,	09

	gluconeogenesis, glucuronic acid pathway. Metabolic sources of acetyl CoA. Glyoxylate cycle.	
Unit-III	**Protein Metabolism** • Protein Structure – Primary, Secondary and tertiary structure. Reactions -Transamination, deamination, Fate of amino acid skeleton, urea cycle, precursors for compounds other than proteins	**09**
Unit-IV	**Nucleotide Metabolism** • Salvage and de-novo pathways of purine and pyrimidine nucleotide biosynthesis. Formation of deoxyribonucleotides, the origin of thymine. Biosynthesis of Nucleotide coenzymes. Nucleotide degradation: catabolism of purines and pyrimidines, the fate of uric acid.	**09**
Unit-V	**Lipid Metabolism** • Lipid biosynthesis, β-oxidation of saturated and unsaturated fatty acid and its regulation. Significance of ketone bodies, Biosynthesis of palmitate and its regulation. Mitochondrial and microsomal pathways of chain elongation, long-term dietary changes, and enzyme level. Metabolism of cholesterol: Biosynthesis of cholesterol and its regulation, lipoprotein metabolism	**09**

Suggested Readings/Reference Books:

1. Biophysical chemistry Principles and techniques: Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath.
2. Instrumental Methods of Analysis6th Edition. (1986): H.H. Willard, L.L. Merritt Jr. andothers.CBS Publishers and Distributors.
3. Instrumental Methods of Chemical Analysis. (1989): Chatwal G and Anand, S. HimalayaPublishing House, Mumbai.
4. A Biologists Guide to Principles and Techniques of Practical Biochemistry. (1975):Williams, B.L. and Wilson, K.

5. Spectroscopy. (Vol. 1): Edited by B.B. Straughan and S. Walker. Chapman and HallLtd.
6. Gel Electrophoresis of Proteins- A Practical Approach: Hanes.
7. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
8. Analytical Biochemistry: Holme.
9. Introduction to High Performance Liquid Chromatography: R. J. Hamilton and P. A. Sewell.
10. Spectroscopy: B.P. Straughan and S. Walker.
11. Practical aspects of Gas Chromatography and Mass Spectrometry (1984) by GordonM.Message, John Wiley and Sons, New York.
12. Gel Chromatography by Tibor Kremmery.
13. Principles and Techniques of Biochemistry and Molecular Biology: Edt. Keith Wilson, John Walker
14. Understanding enzymes 3rd ed. (1991): Trevor Palmer, Prentice Hall
15. Enzyme structure and mechanism: Alan Fersht.
16. Methods in Enzymology: S. Berger, A. Kimmel.
17. Fundamentals of Enzymology; N. Price, L. Stevens.
18. Immobilization of Enzymes and cells. Gordon Bickerstaff

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FOR/DSE/506P	Practical based on FOR/DSE/506T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Biochemistry (FOR/DSE/506T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. pH, Buffers, Buffering capacity
2. To perform serum electrophoresis.
3. Estimation of Amino Acid (Tyrosine)
4. Estimation of Nitrogenous Base (Guanine)
5. Detection of phenylketonuria
6. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
7. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC
8. Quantitative estimation of hydrocarbons/pesticides/organic Solvents /methane by Gas chromatography.
9. Separation of serum protein by horizontal submerged gel electrophoresis.
10. Separation of haemoglobin by gel filtration.
11. Spectrophotometric analysis of dispersible tablets (Paracetamol, dispirin, etc).
12. Effect of temperature on enzyme activity
13. Effect of Substrate concentration on enzyme activity (alpha amylase, starch hydrolysis, Sumner's method) Proteases (Rosen's method)
14. Effect of pH on Enzyme activity
15. Effects of cofactors on rate of enzyme activity (Calcium ions with amylase)
16. Demonstration of catalase, papain,
17. Chemical estimation of milk protein - Casein
18. Microscopic detection of Fat globules for milk
19. Determination of Km and V max.
20. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/507T	Inorganic Chemistry	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the basic concepts of Inorganic Chemistry

Course Objectives

The course has the following objectives:

- Students will gain the concepts of spectral methods of analysis
- Students will learn synthesis methods, properties, and applications of various metal carbonyls
- Students will have an understanding reaction mechanism of transition metal complexes
- Students will understand the concepts of metal-ligand equilibria in solutions

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of inorganic chemistry
- CO2: Apply chemistry and reaction pathway mechanism in metal carbonyls correlation with biological systems
- CO3: Illustrate application of inorganic chemistry in forensics
- CO4: Compare various trace metals in biological systems
- CO5: Develop a framework for chemical analysis of forensic Sample

Unit	Course Content	Contact Hours
Unit-I	**General introduction of spectral methods of analysis** • Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter-absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra. basic elements of practical spectroscopy, resolving power, signal to noise ratio. Uncertainty relation and natural line width, natural line broadening, intensity of spectral lines, energy levels, selection rules, components of spectrometer and their functions.	09
Unit-II	**Chemistry of Metal Carbonyls** • Classification, Chemistry of carbonyl group Preparation, properties, structures, and bonding in -iron carbonyls, Ni(CO)4, Co2(CO)8, Mn2(CO)10, Cr(CO)6, Mo(CO)6 and W(CO)6, Co4(CO)12 and	09

	V(CO)6. EAN rule applied to these carbonyls structures of mixed carbonyls of transition metals and EAN rule applied to these carbonyls. Preparations of carbonyl halides	
Unit-III	**Reaction mechanism of transition metal complexes** • Classification of inorganic reactions, ligand substitution reaction and their mechanisms of octahedral complexes. Acid hydrolysis, factors affecting the acid hydrolysis. Base hydrolysis, conjugate base mechanism. Electron transfer reaction: mechanism of inner and outer sphere electron transfer reactions in octahedral complexes.	**09**
Unit-IV	**Metal ligand equilibria in solution** • Definition of stability constant, step wise and overall formation constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Determination of formation constant for binary complexes using pH-metric technique.	**09**
Unit-V	**Inorganic chemistry in biological systems** • Essential and trace elements in biological systems and their functions, structure and function of metalloporphyrins, Haemoglobin, cytochrome and hemocyanine. Electron transfer, Respiration and photosynthesis reaction, Metal deficient diseases of Fe, Zn, Cu and Mn and their therapy.	**09**

Suggested Readings/Reference Books:

1. Concise Inorganic Chemistry, J. D. Lee.
2. Inorganic Chemistry, J. E. Huhey and Keiter R. L
3. Symmetry and Spectroscopy of Molecules, K. Veera Reddy.
4. Group Theory and symmetry in Chemistry, Gurdeep Raj. Ajay Bhagi and Vinod Jain.
5. Symmetry and Group theory in Chemistry, R. Ameta

6. Mechanism of Inorganic Reaction. II Edn. Fred Basolo and R.G.Pearsons.
7. Selected Topic in Inorganic Chemistry, Wahid U. Malik, G.D.Tuli and R.D.Madan.
8. Advanced Inorganic Chemistry, F.A.Cotton and Wilkinson.
9. Advanced Inorganic Chemistry, Satyaprakash, G.D.Tuli, S. K. Basu and R. D. Madan.
10. Advanced Inorganic Chemistry, Volume I and II Gurdeep Raj.
11. A Textbook of bioinorganic chemistry, A. K. Das

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FOR/DSE/507P	Practical based on FOR/DSE/507T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Inorganic Chemistry (FOR/DSE/507T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

I. Preparation and estimation of percentage metal ion present in metal complexes.

1. $Ti(C_9H_8NO)_2.2H_2O$
2. $VO(acac)_2$
3. Cis-$K[Cr(C_2O_4)_2(H_2O)_2]$
4. $[Mn(acac)_3]$
5. $K_3[Fe(C_2O_4)_3]$
6. $Hg[(Co(SCN)_4]$
7. $[Co(III)(NH_3)_6]Cl_3$
8. $[Co(III)(NO_2)(NH_3)_5]Cl_2$
9. $[Ni(NH_3)_6]Cl_2$

II. Separation and estimation of amount of metal ions from the following mixture solutions

1. Copper- Nickel
2. Nickel- Zinc
3. Iron- Magnesium

III. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/508T	Insurance Forensics-I	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the basic concepts of insurance, insurance fraud, and its investigation.

Course Objectives

The course has the following objectives:

- Students will gain the concepts of risk and risk assessment
- Students will learn an overview of insurance and its types
- Students will have an understanding of insurance regulatory authorities and legal framework
- Students will understand the concepts of research in the insurance sector

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of risk, insurance and insurance fraud
- CO2: Classify various insurance frauds
- CO3: Analyze insurance frauds critically
- CO4: Compare various insurance claims
- CO5: Present the scientific evidence in the court of law

Unit	Course Content	Contact Hours
Unit-I	**Introduction to Insurance Sector** • Terms involved in the insurance sector: insurer, insured, investigator, surveyor, premium, sum assured, Close Proximity, Floater Policy, Endorsement, Coverage, Clauses, etc. • Risk: types of Risk, managing risk, sources and measurement of Risk, risk Evaluation and Prediction • Meaning of Actuary, and Actuarial Science. • Nature of Insurance Contract, Principle of Utmost Good Faith, Insurable Interest, proximity cause, legal Aspects of Insurance Contract • Concept of Insurance, Need for Insurance, Endowment – Types of Insurance Life insurance – General Insurance.	09

	• Types of general insurance – 1. Motor Insurance (2 wheelers, 4 wheelers, excavators, JCBs and other such vehicles), 2. Non-motor Insurance (Property Insurance due to fire, theft, natural calamity etc). Health Insurance, Marine Insurance (Ownership of stocks, customs policies etc).	
Unit-II	**Insurance Frauds-I** • Regulation of Insurance in India, Control of Malpractices, Negligence, Computation of Insurance Premium • Background of the Frauds in Insurance sector, types of People commit insurance fraud (organized criminals, professionals and technicians, ordinary people) • Classification of Insurance frauds. Types of Insurance Fraud (Application Fraud, Illegitimate Denial Fraud, False Claims Fraud, Faked Death Fraud, Inflation Fraud, Forgery and Identity Theft Fraud, False Police Reports).	**09**
Unit-III	**Insurance Frauds -II** • Frauds in General Insurance companies, Fraud Scenarios, Key Statistics in Insurance Fraud, Anti-Fraud Policies, Fraud Monitoring Function • Money Laundering in Insurance sector companies, Money Laundering Methods in the Insurance Sector, Anti Money Laundering in the Insurance Sector, Duties and Responsibilities for AML Compliance, Due Diligence for Insurance, Early warning signals of Insurance sector frauds, Fraud Risk Management in India. Purchase of multiple policies	**09**
Unit-IV	**Insurance Frauds-III** • Introduction to research in Insurance Frauds, types of Research methodology in Insurance frauds, (case	**09**

	study, data collection, preparation of research investigation plan, preparation of questionnaires, personal interview and interrogations, search of physical and digital evidence, OSINT, Data mining, cyber investigation, response collection, data analysis of survey response. Fraud reconstruction, setting up the Special Investigation Unit, Research on Insurance frauds, Investigation techniques, Prevention techniques	
Unit-V	**Introduction to Insurance Fraud Investigation** • Overview and purpose of insurance fraud investigation • Role of Insurance Fraud Investigator • Importance of Insurance Fraud Investigation • The code of ethics • Insurance Fraud Prevention Model Act • Legal framework governing insurance fraud investigation	**09**

Suggested Readings/Reference Books:

1. Insurance Industry in India: Features, Reforms and Outlook Uma Narang
2. GENERAL INSURANCE WORKBOOK Saraswati Sankar Madhuri Sharma A. N. Kaikini
3. Insurance Fraud Casebook: Paying a Premium for Crime by Laura Hymes Edited by Joseph T. Wells
4. Insurance Fraud Handbook by JAMES E. WHITAKER, CFE, CPP, PCI, CIFI

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FOR/DSE/508P	Practical based on FOR/DSE/508T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Insurance Forensics-I (FOR/DSE/508T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Experiment on Evaluation and Prediction risk of (insurance).
2. Experiment with the Principle of Utmost Good Faith
3. Computation of Insurance Premium
4. Experiment (Estimation of Early warning signals of Insurance fraud) predictive methods
5. Experiments on methods and techniques of Due Diligence.
6. Working on different causes of loss in a fire case
7. Experiment on research methods in insurance frauds with case data
8. Experiment on insurance fraud data analysis.
9. Practical on OSINT Tools in Insurance Investigation
10. Practical on tools and techniques in insurance data mining
11. Recovery of evidence related to insurance frauds (Digital means)
12. Recovery of evidence related to insurance frauds (physical means)
13. Examination of signature of insurance bearer for genuineness
14. Examination of photographs of dead/live client
15. Examination of voice of the person claimed to be call from insurance company
16. Examination of Handwriting of insurance bearer
17. Any other practical designed by the faculty member based on recent advances/ latest trends

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Research Methodology

FOR/RM/509	Research Methodology and Statistics	Credit:04	Contact Hours:60	Marks:100

Course Overview

Research is an important aspect of the academic growth of an individual. Research means contributing something new to the existing stock of knowledge. In addition to the general component of research, what is important is a validation of data and its analysis. Statistics helps to collect, present, analyze, and interpret the data collected during the research. Combining both components, the course has been designed to give the complete idea of scientific research and its statistical analysis.

Course Objectives

The course has the following objectives:

- To make the students aware of the concepts of research
- To facilitate the students to make a research plan
- To enable the students to do scientific writings
- To enable students to apply statistical methods in their research
- To enable students to design their research methods

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Explain the concepts of research process, writing of research, basics on descriptive statistics, basics of inferential statistics and probability.
- CO2: Execute literature review, select research problem, formulate hypothesis, collect data, analyze the data and test the hypothesis.
- CO3: Draw connections between various ideas presented in a research article/journal and book.
- CO4: Author master dissertation, research paper and present the findings in a conference.
- CO5: Apply statistical tools to calculate central tendency, dispersion and higher statistics.
- CO6: Test the hypothesis for both small and large samples.

Unit	Course Content	Contact Hours
Unit-I	**Fundamentals of Research** • Introduction to research methodology, definition and basic concepts of research, objectives of research, motivation behind a research, types of research, research process: defining research problem, review the literature, formulation of hypothesis, research design, collection and analysis of data, interpretation	12

	and writing a report. Criteria for good research, measuring research impact and quality: JCR report, impact factor and citation index, ethics and scientific conduct, Ethics in human and animal studies.	
Unit-II	**Writing and Presenting Research** • Components of research paper: the IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustration; preparation for publication, submission of manuscript, publication processes; presentation of research: oral and poster presentations, presentation and submission of research proposals to the funding agencies. • A brief idea about funding agencies for research and development: UGC, CSIR, DFSS, DST, ICMR, BPR&D, DBT, BARTI. • Plagiarism: definition, types, consequences, UGC regulations.	**12**
Unit-III	**Basic Concepts of Statistics and Data Analysis** • Basic definitions and applications of statistics, sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data. Methods of data presentation-graphical representation by histogram, polygon, ogive curves and pie diagram. Measures of central tendency: mean, median and mode; measures of dispersion: range, mean deviation, standard deviation, variance, quartile, standard error and coefficient of variation; correlation and regression: positive and negative correlation and calculation of Karl-Pearson's coefficient of correlation, skewness and kurtosis.	**12**

Unit-IV	**Probability** • Introduction to probability theory, various definitions of probability. Basic terms: random experiments, event, trial, sample space, independent and mutually exclusive events, exhaustive events; conditional probability, addition and multiplication theorem, Bayes' theorem, likelihood ratio, and discriminating power. Distribution of data: normal, binomial, and Poisson distribution.	**12**
Unit-V	**Test of Hypothesis** • Introduction and concepts; test for small and large sample: Z-test, t-test, chi-square test, F-test and ANOVA. • Software related to statistical analysis	**12**

Suggested Readings/Reference Books:

1. Fundamentals of Statistics (2018). S C Gupta, Himalaya Publishing House
2. Statistics in Biology, (1967) Vol. 1: Bliss, C.I.K. McGraw Hill, New York.
3. Practical Statistics for experimental biologist (1985): Wardlaw, A.C.
4. Statistical Methods in Biology (2000): Bailey, N.T. J. English Univ. Press.
5. Biostatistics - 7th Edition: Daniel
6. Fundamental of Biostatistics: Khan
7. Bio-statistical Methods: Lachin
8. Statistics for Biologist (1974): Campbell R.C. Cambridge
9. Research Methodology Tools and Techniques: H.C Purohit
10. Research Methodology: An Introduction: Wayne Dean Goddard, Stuart Melville
11. Research Methodology for Biological Science: Gurumani N Gurumani
12. Research Methodology- G.R. Basotia and K.K. Sharma.
13. Research Methodology- C.H. Chaudhary, RBSA Publication
14. Research Methodology: An Introduction - Wayne Goddard & Stuart Melville
15. Research Methodology - Ranjit Kumar
16. Research Methodology: Methods & Techniques - Kothari, C.R.

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Semester-II

Detailed Curriculum of Semester-II

Discipline-Specific Core Courses

FOR/MJ/550T	Advanced Forensic Science-IV	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers basic concepts of toxicology, narcotics, explosives, and arson cases.

Course Objectives

The course has the following objectives:

- Students will gain an idea of petroleum, petroleum product, and arson
- Students will learn and analyze the various drug of abuse
- Students will have an understanding of various poison and their toxicological analysis
- Students will learn types of explosive and their analysis

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of arson, explosive, poison, and drug of abuse
- CO2: Apply various scientific techniques for arson, explosive, drug, and poison analysis
- CO3: Analyze various biological matrices for toxicological analysis
- CO4: Compare chemical constituents of drug
- CO5: Reconstruct the crime scene of arson and explosion cases

Unit	Course Content	Contact Hours
Unit-I	**Arson and Petroleum products investigation** • Introduction and scope of Forensic Chemistry • Petroleum: Origin, composition, fractionation • Petroleum products: Introduction and properties • Testing of petroleum products: Analysis of petrol, kerosene, and diesel as per BIS/ASTM specifications • Chemistry of fire: Light and flame, triangle of fire, combustion reaction, fire behavior, fire tetrahedron; Stages of fire, Fire patterns; determining origin and cause of fire • Fire/arson scene investigation • Analysis of fire/arson debris	09
Unit-II	**Drugs of Abuse**	09

	• Introduction to drug of abuse: drug dependence, drug addiction • Classification of drug of abuse: depressant, stimulant, and hallucinogens • Depressants: opium and opioids, barbiturates and benzodiazepines; Stimulants: cocaine, nicotine, and amphetamines; Hallucinogens: cannabis, phencyclidine, and LSD • Methods of extraction of drug (acidic, basic, and neutral) from biological matrices such as blood, urine, saliva, vomit, and viscera. • Preliminary and confirmatory analysis of drugs • Forensic examination of trap cases	
Unit-III	**Forensic Toxicology-I** • Introduction and scope of Forensic Toxicology • Classification of poisons • Diagnosis of poisoning in living and the dead • Collection, handling and preservation of toxicological samples, interpretation of toxicological findings and preparation of reports • Extraction: Introduction and fundamental principles of extraction • Introduction to Solid-liquid extraction, Liquid-Liquid extraction (LLE), Solid Phase extraction (SPE), Solid phase micro-extraction and Supercritical Fluid Extraction • **Metallic poisons:** Extraction and isolation of metallic poisons from various biological matrices and their subsequent identification.	**09**
Unit-IV	**Forensic Toxicology-II** • **Liquors:** Introduction, classification of commercial liquors/country made/illicit liquor, origin of liquors • Manufacturing of liquors: Fermentation and distillation methods (pot still and continuous still) • Liquor analysis: Analysis of liquors according to BIS specifications • Analysis of ethyl alcohol, methyl alcohol and denaturants in beverages, liquor, biological fluids (blood and urine): Color tests, GC, Headspace-GC, and GC-MS methods	**09**

	• Breath analyzer: Principle, mechanism, types of breath analyser, blood-alcohol sample collection and preservation • **Plant poisons:** Introduction, active constituents, signs and symptoms, fatal dose, fatal period, postmortem appearance of the Neurotic, Cardiac and Irritant poisons • Extraction and stripping of plant poisons from various matrices and their identification using color tests and instrumental techniques	
Unit-V	**Explosives** • Explosives: Introduction, classification, chemistry of explosives; deflagration and detonation phenomenon • Explosion process • Characteristics of low and high explosives • Improvised Explosive Devices (IED) and Pyrotechnics • Country-made bombs • Forensic examination of explosives: Specific approach to the scene of explosion and analysis of explosive residues	**09**

Suggested Readings/Reference Books:

1. Saferstien: Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA Yinon Jitrin (1993)
2. Mathew E. Johll (2009) Investigating Chemistry: A Forensic Science Perspective Saferstein (1976) Criminalistics.
3. Modern Methods & Application in Analysis of Explosives, John Wiley & Sons, England
4. J A Siegel, P.J Saukko (2000) Encyclopedia of Forensic Sciences Vol. I, II and III, Acad. Press.
5. Moffat, A.C. (Editor) : Clark's Isolation and Identification of Drugs, 1996.
6. Suzanne Bell (2009) Drugs, Poisons, and Chemistry.
7. DFS Manuals of Forensic Chemistry and Narcotics.
8. Modi's Medical Jurisprudence and Toxicology-23rd Ed. Publisher-Lexis Nexis Butter worths Wadhwa.
9. Parikh's Textbook of Medical Jurisprudence, Forensic medicine and Toxicology- C.K. Parikh. CBS Publishers and Distributors.6th Ed.
10. Anil Aggrawal, Essentials of forensic medicine and toxicology, Avichal publishing company.
11. Casarett & Doll Toxicology, The basic Science of Poisons.
12. DFS Manual Forensic Toxicology.
13. Clark, E.G.C.; Isolation and Identification of Drugs, Vol. I and Vol. II, Academic Press, London (1986).
14. Analysis of Plant Poisons, Dr. M P Goutam.

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FOR/MJ/550P	Practical based on FOR/MJ/550T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Advanced Forensic Science-IV (FOR/MJ/550T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practicals has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Determination of methanol and ethanol in alcoholic liquors.
2. Analysis of dye in petrol by UV-Visible spectroscopy.
3. Analysis of alcoholic liquor as per BIS specifications.
4. Chemical analysis of liquors.
5. Extraction and detection of petrol, kerosene, and diesel in fire debris by TLC.
6. Systematic identification of narcotic drugs and psychotropic substances by color test.
7. Identification of drugs of abuse by TLC.
8. Extraction and identification of acidic and basic drugs from biological matrices.
9. UV/Visible spectrometric analysis of NDPS.
10. Systematic analysis of viscera and blood in case of poisoning.
11. Extraction of poisons from hair samples.
12. Extraction and identification of metallic poisons from viscera using dry ashing method followed by Reinsch test.
13. Detection of metallic poisons in foodstuff.
14. Preliminary analysis of explosion residues.
15. Analysis of explosive residues by spot tests and FTIR.
16. Analyses of hand wash in trap cases by TLC and spectroscopy.
17. Extraction and identification of plant poisons from biological matrices.
18. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/551T	Advanced Forensic Science-V	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers basic concepts of forensic biology, serology, and forensic medicine

Course Objectives

The course has the following objectives:

- Students will gain an idea of forensic biology
- Students will learn and analyze the serological samples
- Students will have an understanding of various concepts of medicolegal analysis
- Students will understand the concepts of DNA analysis

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of forensic biological sciences including forensic medicine
- CO2: Apply various biological techniques for forensic analysis
- CO3: Analyze biological matrices of forensic relevance
- CO4: Compare properties of various biological evidences
- CO5: Reconstruct the crime scenario based on biological evidences

Unit	Course Content	Contact Hours
Unit-I	**Forensic Serology** • Blood: History, components, physiology, groups. Identification Techniques: species of origin, blood grouping from blood stains (preliminary and confirmatory) • Semen: History, components, physiology. Identification Techniques • Saliva and other body fluids: History, components, physiology, Identification techniques • Forensic application of serum protein and red cells enzyme • Biochemistry and genetics of ABO, Rh, MN, systems, blood specific • ABH substances, Lectins, and their forensic importance	09
Unit-II	**Forensic Biology** • Hair and Fiber: Nature, Morphology Type, Structure, Location, Collection, Examination and its forensic significance. • Pollens and Diatoms: Nature, Morphology, Type, Structure, Location, Collection, Examination, and their forensic significance.	09

	• Fungi and other botanical evidence (wood): Nature, Morphology, type, Structure, Location, Collection, Examination, and their forensic significance.	
Unit-III	**Forensic DNA Fingerprinting** • DNA: History, Structure, Gene, DNA as genetic Marker, Heredity, Alleles, Mutations, etc. • DNA Phenotyping: DNA markers RELP, RAPD, VNTRs, SNP, Autosomal – STR, Y-STR, Mitochondrial DNA. • DNA Profiling: History, DNA Recombination, DNA Extraction, and Quantification; PCR, Forensic significance of DNA Fingerprint.	**09**
Unit-IV	**Forensic Medicine-I** • Forensic Medicine: Background, Definition, Scope, Indian and global scenario of forensic medicine. • Death: Background, Definition, Types, Stages, Mode, Manner, Signs • Post Mortem Changes: Immediate; stoppage of tripod system of life, Early: eyes changes, Pallor Mortis, Algor Mortis, Livor Mortis, Rigor Mortis, Late: Decomposition & Putrefaction, Medico-legal signs and importance of decomposition, Adipocere formation, Mummification etc. • Forensic Entomology: Introduction, Insects of forensic importance, life cycle of the insects, forensic significance of Insects.	**09**
Unit-V	**Forensic Medicine-II** • Injury: Introduction, Definition, Classification, Medico-Legal aspect of mechanical injury; Abrasion, Bruises, Laceration, Incised, Chopped, Stab wound. Medico-legal aspect of firearm injury. • Sexual offences: Introduction, types: Impotence, Rape, Virginity and its medico-legal examination and disputed unnatural sexual offences • Forensic Anthropology: Human skeleton, types of bone, structure of bone, Forensic determination of species, sex, age, stature and individual identification from Skelton remains. • Forensic Dentistry: Human dentition, Teeth Structure, Teeth types, Age estimation: eruption of teeth & Gustafson method, Bite Mark: introduction and its forensic signification.	**09**

Suggested Readings/Reference Books:

1. Application areas of anthropology by Anil Mahajan & Surinder Nath, Reliance

Publishing house.
2. Physical Anthropology" by B.R.K. Shukla & Sudha Rastogi, Palaka Prakashan.
3. Introduction to Forensic Anthropology, Steven N. Byers, Pearson/Allyn and Bacon,2011.
4. Forensic Anthropology: Current Methods and Practice, Angi M. Christensen,Nicholas V. Passalacqua and Eric J. Bartelink, Academic Press, USA, 2014.
5. Textbook of Forensic Medicine and Toxicology, Anil Aggrawal, Avichal Publishing Company, 2014.
6. Textbook of Forensic Medicine and Toxicology, Nageshkumar G Rao, Jaypee Publishers, 1999.
7. The essentials of forensic medicine and toxicology, Dr. R. K. Narayana reddy, Published by K. Suguna Devi, Hyderabad.
8. Textbook of Forensic Medicine and Toxicology, Dr. V V Pillay
9. Modi's textbook of medical jurisprudence and toxicology.
10. Forensic recovery of human remains: archaeological approaches, Tosha L. Dupras,John J. Schultz, Sandra M. Wheeler and Lana J. Williams, CRC Press, USA 2011
11. Forensic Dentistry, second edition, David R. Senn, Paul G. Stimson
12. Bitemark evidences:colored atlas and text, Robert B.J. Dorion
13. An Introduction to Forensic Genetics, (2007): Goodwin William, John Wiley & Sons Ltd
14. Fundamentals of Genetics,(2006) :Singh, B.D., Kalyani Publishers
15. Forensic DNA Typing: Biology, Technology, and Genetics behind STR Markers by John M. Butler.
16. Fundamentals of Forensic Science (2010), Max M. Houck, Jay A. Siegel, Academic Press Publishers.
17. Forensic Biology, 2 nd edition, Richard Li (2015), CRC Press.
18. Forensic DNA Evidence Interpretation (2005), John buckleton, Christopher M. Triggs, Simon J. Walsh, CRC Press.
19. A forensic DNA Biology laboratory manual (2013), Kelly M. Elkins, Elsevier (AP)
20. Forensic Biology (2015), Max M. Houck, Elsevier (AP)

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FOR/MJ/551P	Practical based on FOR/MJ/551T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Advanced Forensic Science-V (FOR/MJ/551T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practicals has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To perform precipitin test for species of origin determination.
2. Identification of blood group from the suspected blood stains.
3. To determine blood group from various body fluids with Absorption inhibition, mixed agglutination and absorption-elution techniques.
4. Microscopic study of sperm using compound microscope.
5. Forensic examination of semen from stains of various surfaces.
6. Forensic examination of saliva and its stains of various surfaces.
7. Forensic examination of urine, fecal and sweat stains from various surfaces.
8. Determination of age, sex, race and stature from the skeleton remains.
9. Estimation of age on the basis of eruption of teeth and Gustafson method.
10. Classification of dental numbering system.
11. Forensic examination and comparison of bite marks on different surfaces.
12. Preparation of human DNA identification: cell breakage, Removal of protein,
13. Removal of RNA, Removal of DNA, Concentration of DNA.
14. Determination of purity and quantity of DNA.
15. Separation of m-DNA from different sources.
16. Detection and identification of DNA by different methods: staining method etc.
17. Forensic identification and comparison of human hair.
18. Forensic identification and comparison of natural and man-made fibers.
19. Extraction, comparison and identification of pollen from different sources.
20. Extraction, comparison and identification of diatoms from Bones, water samples, other biological evidence.
21. Forensic examination of fungi
22. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/552T	Advanced Forensic Science-VI	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers basic concepts of forensic digital and multimedia sciences.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the basics of computers and computer operations
- Students will learn about computer crime and handling crime scene related to computer crimes
- Students will have an understanding of tools and techniques used to analyses computer crimes
- Students will understand various multimedia evidences
- Students will learn the biometrics and its applicability

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain basics terms of digital and multimedia sciences
- CO2: Apply various tools and techniques to handle digital evidences
- CO3: Analyze digital evidences
- CO4: Compare intrinsic and extrinsic traces in various digital evidences
- CO5: Reconstruct the crime scenario based on available evidence

Unit	Course Content	Contact Hours
Unit-I	**Foundation to Digital and Multimedia Sciences** • Basics of computer operation, hardware, and software • Number systems: binary and hexadecimal • Types of memory and storage of data • File systems • File extensions and file signatures • Basics of computer networks	09
Unit-II	**Basics of Digital and Multimedia Sciences** • Introduction to Digital evidence and Digital Forensics • Computer crimes and their types • History and terminology of computer crime investigation • Handling the scene of crime in computer-related crimes: steps, evidence collection, and reconstruction	09

	• A brief introduction to IT Act and admissibility of electronic/digital evidences	
Unit-III	**Tools and Techniques** • Memory Forensics: tools and techniques • Forensic Examination of Window Systems • Forensic Examination of Linux and Macintosh System • Forensic Examination of Computer Networks • Mobile Forensics: tools and techniques	**09**
Unit-IV	**Multimedia Forensics** • Introduction to multimedia forensics • Basics of audio, video, and image • Manipulation techniques for audio, video, and image • Detection techniques for manipulation in audio, video, and image • Device recognition from intrinsic traces • CCTV footage and its analysis	**09**
Unit-V	**Biometrics** • Introduction to the biometric and biometric system • A general overview of components and working of a biometric system • Physiological biometrics and system: fingerprint, face, iris, palm print • Behavioural biometrics and system: voice, signature, gait • Soft biometrics • Multi-biometric system and security issues	**09**

Suggested Readings/Reference Books:

1. Eoghan Casey, Digital Evidence and Computer Crime: Forensic Science, Computers and the Internet, Second Edition, Academic Press, 2004
2. Eoghan Casey, Digital Evidence and Computer Crime: Forensic Science, Computers and the Internet, Third Edition, Academic Press, 2011
3. John Sammons, The Basics of Digital Forensics, Syngress, Elsevier, 2012.
4. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, 2013
5. Stephen Pearson and Richard Watson, Digital Triage Forensics: Processing the Digital Crime Scene, Syngress, Elsevier, 2010.
6. Brian Carrier, File Systems Forensic Analysis, Addison-Wesley Professional, 2005
7. Gerard Johansen, Digital Forensics and Incident Response: A practical guide to deploying digital forensic techniques in response to cyber security incidents, Packt, 2017.

8. Anil K. Jain, Arun A. Ross and Karthik Nandakumar, Introduction to Biometrics, Springer, 2011.
9. Ruud M. Bolle, Jonathan H. Connell, Sharath Pankanti, Nalini K. Ratha and Andrew W. Senior, Guide to Biometrics, Springer, 2004.
10. Anthony T.S. Ho and Shujun Li, Handbook of Digital Forensics and Multimedia Data and Devices, John Wiley and Sons, 2015

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FOR/MJ/552P	Practical based on FOR/MJ/552T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Advanced Forensic Science-VI (FOR/MJ/552T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practicals has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Retrieval of deleted data from the various memory devices
2. Calculating hash value of a given file/folder/disc
3. Retrieval of deleted data from mobile devices
4. Examination of source of email
5. Examination of various logs of a window system
6. Examination of various logs of a Linux system
7. Examination of various logs of a Macintosh system
8. Examination of a network to check its vulnerability
9. Examination of a crime scene in case of a digital crime
10. Compare face/iris/fingerprint/voice for their origin
11. Examine the authenticity of an image/video/audio
12. Enhancement of CCTV footage
13. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/553P	Skill/Practical-Based Activity-II	Credit:02	Contact Hours:60	Marks:50

Course Overview

The course has been designed to let the students acquire skills in his/her area of interest. As the aim of the course is to develop skills, the students can choose any one group of activities, which can be conducted under the guidance of a teacher. At the end, the student has to prepare a report on the skill acquired listing the practical work carried out throughout the semester

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/553A	Skill based on Forensic Physics -II	02	60	50
		OR			
2	FOR/MJ/553B	Skill based on Digital Forensics-II	02	60	50
		OR			
3	FOR/MJ/553C	Skill based on Forensic Biology II	02	60	50
		OR			
4	FOR/MJ/553D	Skill based on Forensic Chemistry-II	02	60	50
		OR			
5	FOR/MJ/553E	Skill based on Questioned Document, Fingerprint, and Biometrics-II	02	60	50

FOR/MJ/553A	Skill based on Forensic Physics-II	Credit:02	Contact Hours:60	Marks:50

List of activities

Forensic Physics and Ballistics

- Use concepts of material science in various forensic problems
- Any other problem identified by the students

OR

FOR/MJ/553B	Skill based on Digital Forensics-II	Credit:02	Contact Hours:60	Marks:50

List of activities

- Study files systems of mobile devices
- Any other problem identified by the students

OR

FOR/MJ/553C	Skill based on Forensic Biology-II	Credit:02	Contact Hours:60	Marks:50

List of activities

- Analysis of a genetic material
- Any other problem identified by the students

OR

FOR/MJ/553D	Skill based on Forensic Chemistry-II	Credit:02	Contact Hours:60	Marks:50

List of activities

- Organic analysis of an unknown material
- Any other problem identified by the students

OR

FOR/MJ/553E	Skill based on Questioned Documents, Fingerprints and Biometrics-II	Credit:02	Contact Hours:60	Marks:50

List of activities

- Exploring methods for insurance fraud investigation
- Any other problem identified by the students

Discipline-Specific Elective Courses

FOR/DSE/554T	Material Science and Forensic Engineering	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers a few topics of material science and their applications in forensics. It covers topics on Forensic Engineering and its applications in solving real crime scenarios.

Course Objectives

The course has the following objectives:

- Students will gain an idea of crystal geometry and the structural analysis
- Students will learn about engineering and taggant materials
- Students will have an understanding of concepts of nanomaterials and their applications in forensics
- Students will learn analysis of building and other engineering materials

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain concepts of various engineering materials
- CO2: Apply concepts of nanoscience for forensic applications
- CO3: Correlate various variables for identification of forensic material
- CO4: Compare constituents of building material for their identification
- CO5: Create a framework for forensic analysis of materials

Unit	Course Content	Contact Hours
Unit-I	**Crystal Geometry and Structure Analysis** • Overview of space lattice, crystal structure, and unit cell. Bravais lattices, symmetry in crystals, calculations of parameters (unit cell volume, number of atoms per unit cell, co-ordination number, atomic radius, packing fraction, void space, density of crystal) of SC, BCC, FCC and HCP structures. • Atom positions in cubic cells, indices of crystallographic direction, lattice planes and miller indices, sketching a lattice plane (hkl), introductory idea of reciprocal lattice. Unit cell volumes, plane spacing and interplaner angles in cubic, tetragonal,	09

	hexagonal, rhombohedral, orthorhombic, monoclinic and triclinic structures. • X-Ray diffraction, reflection of X-ray from different planes and Bragg's law, Bragg's spectrometer, X-ray diffraction methods (Laue method, powder crystal method, rotating crystal method), XRD pattern analysis (Intensity analysis, particle size estimation, indexing of pattern and crystal structure determination). Introduction to various crystal defects.	
Unit-II	**Engineering and taggant materials** • Engineering Materials: Classification (metals, ceramics, polymeric, composites, electronics, biomaterials, advanced materials); Alloy systems and solid solutions. General Properties of Engineering Materials (density, melting temperature, electrical conductivity, thermal conductivity, corrosion resistance, magnetic properties etc.) Mechanical Properties (strength, stiffness, elasticity, plasticity, ductility, brittleness, malleability, toughness, resilience, creep and hardness etc.) • Taggant materials: Taggant materials (physical, chemical, spectroscopic, DNA etc.) and their applications in forensic science (property marking, anti-counterfeiting, tracking, monitoring etc.). Security labels and seals against product fraud.	**09**
Unit-III	**Nano materials** • Nanoscale and its significance, Nano material production techniques: Bottom-up and top-down technique, production of Nano layers, synthesis of Nano particles and carbon nano tubes; Applications of Nano materials in forensic science: Fingerprint identification, explosive residue detection, DNA	**09**

	analysis, Nano trackers, screening of drug-facilitated crime, estimation of time since death, security, etc.	
Unit-IV	**Building Materials** • Introduction to the basic building materials like cement, sand, brick, grit, steel, quality of water, cube rest and curetting etc . Sampling of the materials with relevant information required for the investigation (column, beam, slab, mortar, bricks, reinforcement steel, soil and basic materials used in the construction. ISI/Code of Building Construction, Structural failures, static loads, dynamic loads, causes of structural collapse.	**09**
Unit-V	**Testing of materials** • Materials Testing- Tensile test, compression test, Ductility testing, Impact / toughness testing, Hardness testing (Brinell hardness test, Rockwell hardness test, Vickers hardness, Shore scleroscope). • Methods of analysis of different constituents of Building materials, Steel bars and metal physics. • Testing of Cement (Standard Consistency test, Compressive Strength Test, Setting Times). • Analysis of cement mortar and cement concrete & stones. Examination of brick, analysis of • Bitumen & road materials.	**09**

Suggested Readings/Reference Books:

1. Material Science, 2 nd Edition, S.L. Kakani and Amit Kakani, New Age Int. Publisher.
2. Working procedures Laboratory Manual (Physics Division), DFSL, Mumbai.
3. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi.
4. Alok Pandya, Ritesh K Shukla, New perspective of nanotechnology: role in preventive forensic, review. Egyptian Journal of forensic sciences (2018) 8:57
5. Arshad A, Farrukh M, Ali S, Khaleeq-ur-Rahman M, Tahir M (2015) Development of latent fingermarks on various surfaces using ZnO-SiO2 nano powder. J Fore Sci 60:1182–1187
6. Chen Y (2011) Forensic applications of nanotechnology. J Chin Chem Soc 58:828–835
7. Lad N, Kumar A, Pandya A, Agrawal YK (2016) Overview of nano-enabled screening of drug-facilitated crime: a promising tool in forensic investigation. Trends Anal Chem 80:458–470

8. Lodha A, Pandya A, Sutariya P, Menon S (2013) Melamine modified gold nanoprobe for "on-spot" colorimetric recognition of clonazepam from biological specimens. Anal 138:5411–5416
9. Meng H, Caddy B (1997) Gunshot residue analysis—a review. J Fore Sci 42:14167J
10. Pandya A, Goswami H, Lodha A, Menon S (2012) A novel nano aggregation detection technique of TNT using selective and ultrasensitive nanocurcumin as a probe. Anal 137:1771
11. Shinde SA, Malve MK, Prabha C, Garad MV (2010) Nanotechnology and forensic science. Nanotech and Nano Sci 1(1):19–21
12. Shukla RK (2013) Occupational exposure of nanoparticles in forensic science: a need of safe use. Int J Fore Sci Pathol 1(3):7–10
13. Stankova D (2015) Application of Nanotechnology In Security Taggant materials in Forensic Science: A review, James Gooch, Barbara Daniel, Vincenzo Abbate, Nuzianda Frascione, Trends in Analytical Chemistry (2016).
14. Introduction to Solid State Physics; Cgarles Kittel, Wiley India Pvt. Ltd.
15. Elements of X-Ray Diffraction; B.D. Cullity and S. R. Stock, Pearson.
16. Engineering Physics; M.N. Avadhanulu and P.G. Kshirsagar, S.Chand Company.
17. A Textbook of Physical Chemistry, Vol-1, K.L.Kapoor, Mc Graw Hill.
18. Instrumental Method of Chemical Analysis, by B K Sharma.
19. Instrumental methods of chemical analysis, Gurudeep R. Chatwal, Sham K. Anand, Himalaya publishing house.
20. Principle of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publishing Co.
21. Analytical Chemistry: Theory and Practice, by R.M. Verma, 3rd edition.
22. Electron microscopy and analysis, third edition, Peter J. Goodhew, John Humphreys, Richard Beanland, published 2001 by Taylor and Francis, London and Newyork
23. Forensic Science in Criminal Investigation & Court Evidence, V.N. Sehgal, Selective &Scientific Books, New Delhi.
24. Arora, S. P. & amp; Bindra, S. P., "A Text Book of Building Construction", Dhanpat Rai & amp; Sons, Delhi, 2010.
25. Jha, J. & Sinha, S. K., "Building Construction", Khanna Publishers, Delhi. 1977.
26. Kenneth L. Carper; "Forensic Engineering", Second Edition, CRC Press. 2001.
27. Bureau of Indian Standards: IS 4031 (Part-1,4,5 and 6):1988.
28. Bureau of Indian Standards: IS 3495 (Part-1 to 4):1992.

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FOR/DSE/554P	Practical based on FOR/DSE/554T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Material Science and Forensic Engineering (FOR/DSE/554T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Finding Miller Indices.
2. Sketching various crystal planes.
3. Determination of number of atoms per mm 2 in a plane of unit cell.
4. Intensity analysis of XRD pattern.
5. Determination of crystallite size from a given XRD pattern.
6. Indexing of planes in XRD pattern.
7. XRD pattern analysis of Nano material.
8. Hands on training on XRD machine.
9. Examination of Security labels and seals against product fraud.
10. Determination of Standard Consistency of cement sample.
11. Determination of compressive strength of cement.
12. Determination of Initial and Final Setting Time of cement sample.
13. To estimate dimensions and tolerance, compressive strength, soundness, structure and hardness of suspected bricks.
14. To conduct water absorption and efflorescence test on suspected bricks.
15. To determine Compressive strength of bricks.
16. Preparation of mortar and concrete blocks.
17. To find out the cement content in mortar (mixture of cement and sand) i.e., the ratio of cement and sand in mortar.
18. To find out the cement content in concrete (mixture of cement, sand and aggregate) i.e., the ratio of cement, sand and aggregate in concrete.
19. Determination of compressive strength of concrete.
20. Determination of tensile strength of rope/dupatta.
21. Field Visit report on any ongoing construction of building/ bridge/road etc.
22. Report on Study visit to Civil Engineering Department of any Technical Institution/MERI, Nashik.
23. Case study of structure failure of building/ bridge etc.
24. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/555T	File Systems	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the concepts of file systems in various operating systems.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the basics of file systems
- Students will learn and apply concepts of file systems in the forensic scenario
- Students will have an understanding of concepts of file systems of Windows, Linux and Macintosh operating systems
- Students will learn file systems of the Unix operating system

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of file systems
- CO2: Understand the data structure of various file systems
- CO3: Analyze various file systems
- CO4: Compare characteristics of various file systems
- CO5: Develop a forensic framework for file systems

Unit	Course Content	Contact Hours
Unit-I	**Foundation** • Data Organization and booting process • Hard disk organization • File system and file system category • Application-level search techniques • Specific File Systems	09
Unit-II	**FAT Concepts, Data Structure and Analysis** • FAT: Introduction, file system category, content category, metadata category, file name category, the big picture • Data structures and Analysis: Introduction, File System Category, Content Category, Metadata Category, File Name Category, Boot Sector, FAT32	09

	FSINFO, FAT, Directory Entries, Long File Name Directory Entries	
Unit-III	**NTFS Concepts, Data Structures and Analysis** • Introduction, everything is a File, MFT Concepts, MFT Entry Attribute Concepts, Other Attribute Concepts, Indexes, Analysis Tools, Analysis: File System Category, Content Category, Metadata Category, File Name Category, Application Category. • NTFS Data Structures: Basic Concepts, Standard File Attributes, Index Attributes and Data Structures, File System Metadata Files.	**09**
Unit-IV	**Ext2 and Ext3 Concepts and Analysis** • Introduction, File System Category, Content Category, Metadata Category, File Name Category, Application Category, The Big Picture. • Ext2 and Ext3 Data Structures: Superblock, Group Descriptor Tables, Block Bitmap, I nodes, Extended Attributes, Directory Entry, Symbolic Link, Hash Trees, Journal Data Structures.	**09**
Unit-V	**UFS1 and UFS2 Concepts and Analysis** • Introduction, File System Category, Content Category, Metadata Category, File Name Category, The Big Picture, UFS1 and UFS2 • Data Structures: UFS1 Superblock, UFS2 Superblock, Cylinder Group Summary, UFS1 Group Descriptor, UFS2 Group Descriptor, Block and Fragment Bitmaps, UFS1 Anodes, UFS2 Anodes, UFS2 Extended Attributes, Directory Entries.	**09**

Suggested Readings/Reference Books:

1. File System Forensic Analysis by Brian Carrier

2. Cory Altheide and Harlan Carve, Digital Forensics with open-source tools, Syngress.

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FOR/DSE/555P	Practical based on FOR/DSE/555T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on File System (FOR/DSE/555T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Identify the file structure of an operating system
2. Study the organization of hard disk
3. FAT16 analysis
4. FAT32 analysis
5. NTFS analysis
6. Ext2 System understanding and its analysis
7. Ext3 System understanding and its analysis.
8. Ext4 System understanding and its analysis
9. UFS1 System understanding and its analysis
10. UFS2 System understanding and its analysis
11. Comparative study of window and android file systems
12. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/556T	Genetics and Bioinformatics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the basic concepts of Genetics and Bioinformatics

Course Objectives

The course has the following objectives:

- Students will gain the concepts of Mendelian genetics and chromosomal inheritance
- Students will learn an overview of genome organization structure of DNA
- Students will have an understanding of mutations and repair
- Students will understand the concepts of bioinformatics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of genetics and bioinformatics
- CO2: Apply various techniques for extraction and isolation of DNA
- CO3: Examine DNA samples
- CO4: Compare DNA samples of various species
- CO5: Design and develop computational framework for bioinformatics

Unit	Course Content	Contact Hours
Unit-I	**Mendelian Genetics and Chromosomal Inheritance** • Mendelian laws of inheritance and its deviations, Types of inheritance (Dominant inheritance, recessive inheritance, sex-linked inheritances, and polymorphic traits) Population genetics (Mendelian Population, gene pool, Hardy-Weinberg equilibrium, deviation from H-W equilibrium, Sex chromosomes, Barr body formation, sex linkage, X –linked recessive inheritance, X-linked Dominant inheritance, Y-linked inheritance.	09
Unit-II	**Genome organization Structure of DNA-I** • (A,B and Z forms of DNA) Structure of chromatin, chromosome, centromere, telomere, nucleosome, genome organization, chromatin remodelling; types of histones, histone modifications-methylation,	09

	acetylation, phosphorylation and its effect on structure and function of chromatin	
Unit-III	**Genome organization Structure of DNA-II** • DNA methylation, repetitive and non-repetitive DNA sequence, Law of DNA constancy, C value paradox and genome size. Karyotype and ideogram, Amneocentosis, chromosome banding pattern, types of chromosomes, Giant chromosomes- polytene and lamp brush chromosome	**09**
Unit-IV	**Mutations and Repair** • Mutations and their causes: types of mutation (Chromosomal and Gene) • Chromosomal – Structural and numerical changes, Gene - mutagens, induced mutagenesis (UV, nitrosoguanidine, ethyl methanesulfonate) mutation rate and genetic load. Repair mechanisms (Photoreactivation, Base excision, Mismatch, Nucleotide excision, SOS repair) • Disorders: Metabolic disorders: introduction and examples (Amino acid metabolism - Phenylketonuria, Carbohydrate metabolism: lactose intolerance, genetic disorders (Hemophilia, thalassemia, sickle cell anemia, Down's syndrome, Turners syndrome	**09**
Unit-V	**Bioinformatics** • Bioinformatics and its Applications: EMBL, Gene Bank, protein structure database (PDB), Computational methods, homology algorithms (BLAST, FASTA) for proteins and nucleic acids; primer and probe designing (PCR, STR, SNPs of Mitochondrial and genomic DNA), Preparation of genomic library, Submission of sequence in library.	**09**

	evaluation of primer and probe compatibility. CODIS and NDIS, phylogenetic analysis using various methods.	

Suggested Readings/Reference Books:

1. Genetics a conceptual approach: Fourth edition by Benjamin Pierce.
2. An Introduction to Forensic Genetics: William Goodwin, Adrian Linacre, SibteHadi
3. Forensic DNA Typing: Biology, Technology, and Genetics behind STR Markers by John M. Butler
4. An Introduction to Forensic Genetics, (2007): Goodwin William, John Wiley & Sons Ltd,
5. Basic human genetics (1991): Kapur V, Jaypee Brothers
6. Essentials of Human Genetics (2009): Kothari, Manu L, Universities Press (India) Pvt. Ltd.
7. Fundamentals of Genetics,(2006) :Singh, B.D., Kalyani Publishers
8. Genes IX,(2008): Lewin, Benjamin Jones and Bartlett Publishers
9. Genetic influences on neural and behavioral functions. (2000): Pfaff, Donald W CRC Press
10. Genetic Markers in Human Blood,(1969): Giblett, Eloise R. Blackwell ScientificPublications
11. Genetics, (2003): Winter, P.C; Viva Books Pvt. Ltd.,
12. Genetics Altenburg, (1970): Edgar, Oxford& IBH Publishing Co.
13. Genetics Strickberger, (2005): Monroe, Prentice Hall of India Ltd
14. Genetics, (1998): Hartl, Daniel L Jones and Bartlett Publishers
15. Genetics of populations,(2005):Hedrick, Philip W Jones and Bartlett publishers,
16. Genomic Imprinting, (1995): Ohlsson, R.; Cambridge University Press
17. Human Genetics, (1987): Vogel, Friedrich; Springer –Verlag Berlin Heidelberg,
18. Human Genome methods. (1998): Adolph, Kennetth W CRC Press,
19. Human population genetics in India,(1974): Sanghvi, L.D; Orient Longman Ltd,
20. Concepts of Genetics: Klug W.S. & Cummings M.R., Prentice-Hall
21. An Introduction to Genetic Analysis, Griffith A.F. et al., Freeman
22. Statistical Methods in Human Population Genetics, (1998): K.C. Malhotra Indian Statistical Institute, Calcutta
23. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
24. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
25. Bioinformatic methods and protocols:Misener.
26. Introduction to Bioinformatics by Altwood.
27. Bioinformatics sequence and genome analysis 2nd ed.: David Mount.

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FOR/DSE/556P	Practical based on FOR/DSE/556T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Genetics and Bioinformatics (FOR/DSE/556T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Chromosome banding technique.
2. Extraction and isolation, estimation of DNA from buccal swabs.
3. Extraction and isolation, estimation of DNA from blood and semen
4. Extraction and isolation, estimation of DNA from biological samples (from Cows,Bulls, Buffalos, Chicken fishes, other wildanimals etc.)
5. Restriction digestion of DNA from above samples.
6. Squash preparation of giant chromosome of salivary gland
7. Polytene chromosome staining from salivary glands of Chironomus larvae
8. Determination of purity and quantity of DNA.
9. Extraction of mitochondrial DNA from forensic samples
10. Isolation of Plasmid DNA & Transferring plasmid DNA into bacterial cell
11. Preparation and transformation of competent E. Coli using calcium chloride
12. DNA detection method: fluorescent and silver staining
13. Demonstration of mutation on the basis of bacterial pigmentation.
14. Visit autopsy center at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Centre, Biodiversity and wildlife Centre.
15. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/557T	Organic Chemistry	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the basic concepts of organic chemistry

Course Objectives

The course has the following objectives:

- Students will gain the concepts of bonding in organic molecules
- Students will learn an overview of the reaction mechanism
- Students will have an understanding of the stereochemistry
- Students will understand the concepts of aliphatic-nucleophilic substitution

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of organic chemistry
- CO2: Apply reaction mechanism
- CO3: Illustrate the application of stereochemistry
- CO4: Compare various chemical compounds
- CO5: Develop a framework for chemical analysis of forensic Sample

Unit	Course Content	Contact Hours
Unit-I	**Nature of Bonding in Organic Molecules** • Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant compounds, Huckel rule, the energy level of π-molecular orbitals, annulenes, aromaticity, Bonds weaker than covalent - addition compounds, crown ether complexes, and cryptands, inclusion compounds, cyclodextrins, catenanes, and rotaxanes	09
Unit-II	**Reaction Mechanism: Structure and Reactivity** • Types of Mechanisms, Types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammond's postulate, methods of determining mechanisms, isotope effects.	09

	• Generation, structure, stability and reactivity of carbocations, Carbanions, free redicals, carbenes and Nitrenes. Effect of structure on reactivity, resonance and field effect, steric effect quantitative treatment, The Hammett equation, Linear free energy relationship, substituent and reaction constants, Taft equation.	
Unit-III	**Stereochemistry-I** • Elements of symmetry, chirality, Enantiomeric and diastereomeric relationships, R and S, E and Z nomenclature. Molecules with more than one chiral center, Threo and Erythro isomers, Prochiral relationships, groups and faces, stereospecific and stereoselective reactions.	**09**
Unit-IV	**Stereochemistry-II** • Optical activity in the absence of Chiral Carbon (Biphenyls, allenes, and Spiranes), Chirality due to helical shape. Methods of resolution, optical purity, and stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous. Conformational analysis of cycloalkanes, Mono and disubstituted cyclohexanes, decalins, the effect of conformation on reactivity	**09**
Unit-V	**Aliphatic Nucleophilic Substitutions** • Nucleophilic: The SN^2, SN^1 mixed SN^1 and SN^2 and SET mechanisms. The neighbouring group mechanism, Neighbouring group participation by π and σ -bonds, anchimeric assistance. Nucleophilic Substitution at an allylic aliphatic trigonal and a vinylic carbon. • Reactivity: Effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis, Ambident nucleophiles, regioselectivity.	**09**

Suggested Readings/Reference Books:

1. Advanced Organic Chemistry, IV Edition: J. March
2. Stereochemistry of Carbon Compounds: E. L. Eliel
3. Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg.
4. A Guide Book to Mechanisum in Organic Chemistry: Peter Sykes.
5. Principles of Organic Synthesis: R. O. C. Norman
6. Stereochemistry of Organic Compounds: D. Nashipuri
7. Organic Chemistry: Clayden and Greeves
8. Mechanism and Structure in Organic Chemistry: E. S. Gould

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FOR/DSE/557P	Practical based on FOR/DSE/557T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Organic Chemistry (FOR/DSE/557T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Separation, purification and identification of binary (**Solid-Solid**) mixtures. (Minimum 5 mixtures)
2. To prepare Aspirin from salicylic acid and identification by TLC and M. P. (2)
3. Preparation of Benzanilide from Benzophenone. (single-stage preparation)
4. Preparation of p- nitroaniline from Acetanilide. (single-stage preparation)
5. Preparation of Dibenzylidene acetone from Benzaldehyde (single-phase preparation)
6. Estimation of Vitamin "C" Iodometrically in biological fluids.
7. To determine the dissociation constant of Cu (II) and Fe (III) solution photometrically.
8. Determination of percentage of number of hydroxyl group in an organic compound by acetylation method.
9. Determination of Fe3+ spectrophotometrically with thiocynate using isobutanol as a. extracting agent.
10. To determine sulphate ions by turbidometry.
11. Any other practical designed by the faculty member based on recent advances/ latest trends

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FOR/DSE/558T	Insurance Forensics-II	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the basic concepts of insurance, insurance fraud, and its investigation.

Course Objectives

The course has the following objectives:

- Students will gain the concepts of risk and risk assessment
- Students will learn an overview of insurance and its types
- Students will have an understanding insurance regulatory authorities and legal framework
- Students will understand the concepts of research in insurance sector

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various concepts of risk, insurance and insurance fraud
- CO2: Classify various insurance frauds
- CO3: Analyze insurance frauds critically
- CO4: Compare various insurance claims
- CO5: Present the scientific evidence in the court of law

Unit	Course Content	Contact Hours
Unit-I	**Insurance Investigation Techniques** • Nature and scope of Insurance Investigation, Types of Insurance Claims Investigated, Workers' Compensation Claims, Personal Injury Claims, Property Damage and Theft Claims, Healthcare/Medical Fraud Claims, • Claims Investigation Process, Collecting and Reviewing Documents, Statements, and Interviewing, Surveying the Area and Suspect, Obtaining Other Contextual Information, Surveillance to verify the claim, previous claims/accidents search, Insurance coverage analysis, Witness interviews, Claimant background check, Detailed investigation report (DIR).	09
Unit-II	**Investigation of Health and life insurance case**	09

	• Health Insurance (Nature and scope), types of Health Insurance frauds, Health Insurance case studies and case laws. Investigation of Health Insurance frauds, methods of investigation. Medical reports/history search, field investigation, Health Insurance coverage analysis, Witness interviews, Claimant background check. • Life Insurance (Nature and scope), types of Life Insurance frauds, fake or inflated healthcare claims, Life Insurance case studies and case laws. Investigation of Life Insurance frauds, methods of investigation. Medical reports/history search, field investigation, Life Insurance coverage analysis, Witness interviews, Claimant background check. • Personal Claims. Investigation of Personal Injury Claims frauds. Simulation and reconstruction cases, Detailed investigation report (DIR).	
Unit-III	**Property Damage and Theft Claims investigation-I** • Property Damage nature and scope, type of Property Damage (Due to fire, theft, natural calamity), case studies and case laws. • Investigation of property damage in fire case: methods of investigation, scene investigation and key evidence in fire case, Simulation and reconstruction. Understanding Fire patterns: soot formations, interview techniques of the concerned persons, evaluation of administrative Reports like Police Documents, Fire Reports, Electrical Inspector Report, and other documents. • Evaluation of Digital Evidences: - Call Logs, Google-Timeline, Analysis of CCTV Footage, Metadata of Incident time Photos etc.	**09**

Unit-IV	**Property Damage and Theft Claims investigation-II** • Understanding and Analysis of Fire Safety Services like Fire Extinguishers, Fire Hydrants, Fire Alarms, Smoke Detection system, etc. • Sample Testing: Ash Samples for presence of Hydrocarbons, wire samples for the presence of short-circuit, control samples for quality testing, Understanding types of Fire:- Explosion, Impact, Smouldering, Chemical etc., Understanding Fire Directives, i.e., Origin, Propagation and Cause of Fire, Possible causes in a Fire Case • Theft claims (theft, burglary, hijacking or robbery etc). Nature and scope, type of Theft and Damage, property loss estimation in theft, case studies and case laws. Investigation of Theft claims, method of investigation, scene investigation and key evidence Theft claims case, simulation and reconstruction, detailed investigation report (DIR). • Loss due to natural calamities: - Floods, Riots, Accidents, Rain, Lightning etc.	**09**
Unit-V	**Motor Vehicle Accident Claims Investigation** • Motor Vehicle Accident, Motor Vehicle Accident ACT, Motor Vehicle Accident Statistics, types of Motor Vehicle Accident, Motor Accident Claims Tribunal (MACT), Motor Vehicle Accident investigator, Motor Vehicle Accident Forensics, Investigation of Vehicle Accident, Hit and Run, stolen vehicle, Vehicle involved in crime and terrorist activities • Motor Vehicle insurance and types, Collecting and Reviewing Documents, accident scene investigation, conducting a background check, examination of photos, footages and videos of accident, Taking	**09**

	Statements and Interviewing of witnesses, Medical Reports, and Medical evaluation of accident victims, vehicle inspection and examination, key evidence, simulation, and reconstruction, Detailed accident report (DAR). • Evaluation of Administrative Reports like Police Documents, Fire Reports, Electrical Inspector Report, and other documents. • Evaluation of Digital Evidences: - Call Logs, Google-Timeline, Analysis of CCTV Footage, Metadata of Incident time Photos etc. • Understanding and Analysis of Fire Safety Services like Fire Extinguishers, Fire Hydrants, Fire Alarms, Smoke Detection system, etc. • Sample Testing: Ash Samples for presence of Hydrocarbons, wire Samples For the presence of short-circuit • Understanding types of Fire: Explosion, Impact, Smouldering, Chemical etc. • Understanding Fire Directives, i.e., Origin, Propagation and Cause of Fire, Possible causes in a Fire Case	

Suggested Readings/Reference Books:

1. Compensation for Accidental Injuries: Research Design and Methods D Hensler
2. Insurance: Concepts & Coverage: Property, Liability, Life, Health and Risk Management Marshall Wilson Reavis III
3. GENERAL INSURANCE WORK BOOK Saraswani Sankar Madhuri Sharma A. N. Kaikini
4. Understanding Insurance of Health by P C James
5. Managing Life Insurance Shashidharan K. Kutty
6. Life Insurance, 15th Ed. by Jr. Kenneth Black
7. Insurance Fraud Casebook: Paying a Premium for Crime by Laura Hymes, Edited by Joseph T. Wells
8. Insurance Investigations from A to Z By Kelly E Riddle
9. Insurance Fraud Handbook by JAMES E. WHITAKER, CFE, CPP, PCI, CIFI
10. Financial Expert Witness Communication: A Practical Guide to Reporting and Testimony by Bradley J. Preber

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FOR/DSE/558P	Practical based on FOR/DSE/558T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on Insurance Forensics-II (FOR/DSE/558T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Case study on investigation of health insurance (three experiments)
2. Case study on investigation of life insurance (three experiments)
3. Case study on investigation of fire accident (three experiments)
4. Evaluating digital evidences in fire cases
5. Sample testing in case of fire cases
6. Case study on theft cases (three experiments)
7. Case study on motor vehicle accident (three experiments)
8. Evaluation of administrative reports in motor accident cases
9. Evaluation of digital evidence in motor vehicle cases
10. Understanding fire patterns in motor vehicle accident cases
11. Sample analysis in fire in motor accident cases
12. Analysis of fire safety services
13. Any other practical designed by the faculty member based on recent advances/latest trends

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On Job Training/ Field Project

FOR/DSE/559	On-Job Training/Field Project	Credit:04	Contact Hours:120	Marks:100

Course Overview

As per NEP 2020, the student has to carry out on job training (internship/apprenticeship)/ field project at least for four weeks during the summer vacations. The student can work in the industry/ academic institutions/ research institutions/ laboratories specified by the university/Institute/colleges. On completion, the student needs to produce the certificate of completion. Detailed guidelines will be issued by the university in due course of time.

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Semester-III

Detailed Curriculum of Semester-III

Discipline-Specific Core Courses

FOR/MJ/600T	Special Paper-I	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course has been designed to get the students specialized in a particular domain of forensic science. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/600AT	Examination of Physical Evidence	03	45	75
		OR			
2	FOR/MJ/600BT	Disc and Cloud Forensics	03	45	75
		OR			
3	FOR/MJ/600CT	Botanical Evidence and Environmental Forensics	03	45	75
		OR			
4	FOR/MJ/600DT	Forensic Chemistry of Fire and Explosive	03	45	75
		OR			
5	FOR/MJ/600ET	Printed Documents and Forensics	03	45	75

FOR/MJ/600AT	Examination of Physical Evidence	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the examination process of various physical evidence like glass, paint, soil, cement, and broken objects and the restoration of erased numbers.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the examination of various physical evidence
- Students will learn and analyze the glass and paint
- Students will have an understanding of soil and cement analysis
- Students will understand the analysis of broken objects, fiber, and other physical evidence
- Students will learn the restoration of erased identification marks

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the properties of various physical evidence
- CO2: Apply various scientific techniques in the analysis of glass and paint
- CO3: Analyze evidence like soil, cement, broken objects, fibers, and other evidence
- CO4: Compare properties of various physical evidence
- CO5: Restore erased identification numbers

Unit	Course Content	Contact Hours
Unit-I	**Glass and paint examination** • **Glass:** Overview of composition and types of glass, glass breaking mechanism. Primary examination (appearance, color, fluorescence, surface features, edge thickness, curvature, physical fit), density measurements for bigger fragments of glass, and glass fragment density comparison (by flotation method, density gradient tubes). Density range of common glass. Glass refractive index (R.I) ranges of various glass, R.I. measurement of glass: using Immersion methods (Becke line concept), using a mixture of miscible liquids, using hot stage microscope, Emmons Double Variation and Automated method. Forensic significance of elemental variation in glass and elemental analysis of glass fragments by ICP-MS/LA-ICP-MS. • **Paint:** Components of paint (binder, solvent, pigment and additives). Microscopic examination (physical matching, matching of layers, examination of surface markings, pigment distribution). Microchemical tests, and additional instrumental techniques for identification of paints (Infra-red spectroscopy, X-ray Diffraction, Pyrolysis Gas Chromatography, elemental analysis of the pigments)	**09**
Unit-II	**Soil and cement examination** • **Soil:** Microscopic examination (color, size and shape), microscopical observation with chemical reagents, particle size distribution, ignition test, density distribution of soil particles, pH measurement of soil, examination of soil using X-Ray Diffraction. • **Cement:** Adulteration in cement- bromoform test, fineness test, ignition test, analysis of insoluble residue, compressive strength test (determination of standard consistency, preparation of cube and determination of compressive strength); examination of cement samples and identification of adulterated cement using X-Ray Diffraction	**09**
Unit-III	**Examination of electrical cables and meters**	**09**

	• **Electrical cables/wires:** Physical properties-number of strands, diameter of strand, dye marks, material, twist, color thickness and marks on insulation. • **Tampered electric energy meters:** Meter seal and seal wire examination, hole made on the top of meter body or slit made on meter body (in case of analogue meters), front glass removed and reaffixed, understanding the circuit mechanism of electric energy meter and modifications made for tampering the digital meters.	
Unit-IV	**Examination of miscellaneous evidence** • **Broken objects examination** (bone, bamboo, lathi, nail, tooth, piece of skin, tool, glass, wooden piece, leaf, clothes, ornament, machinery, pipe, wire, paper sheet, pages from a book, newspaper, etc.): Mechanical fit and side by side match. • **Fiber**: Fiber type and color, number of fibers, fabric type; methods of examination: Physical match, microscopic and visible spectroscopic examination of textile fibers, Thin-Layer Chromatographic examination of non-reactive dyes in textile fibers, Infrared analysis of textile fibers.	09
Unit-V	**Restoration of erased Identification marks** • Principle of restoration of marks/numbers, types of identification marks, methods used to obliterate identification marks, chemical etching method for restoration; Preliminary examination, preparation of surface. Etching procedures on different surfaces: 1. Steel surfaces (chassis and engine of cars, guns, gas cylinders, etc.), 2. Copper, brass, German silver, and other copper alloys, 3. Stainless steel, 4. Lead (motor car batteries etc.), 5. Zinc alloys, 6. Cast iron and cast steel, 7. Aluminum alloys (engine surface of motorbikes, auto-rickshaw engine, vehicle identification plates, etc.), 8. Tin, 9. Gold and Platinum, 10. Wood (punched marks), 11. Leather, 12. Rubber, 13. Polymers. Preservation of the restored punched and engraved marks.	09

Suggested Readings/Reference Books:

1. Working procedures Laboratory Manual (Physics Division), DFSL, Mumbai.
2. Forensic Science in Criminal Investigation & Court Evidence, V.N. Sehgal, Selective and Scientific Books, New Delhi.

3. Beveridge, A. D. and Semen, C. Glass density measurement using a calculating digital density meter, Canadian Society of Forensic Science Journal (1979) 12(3):113-116.
4. Kirk, P. L. Density and Refractive Index: Their Application in Criminal Identification. American Lecture Series. Publication 112. American Lectures in Public Protection. Thomas, Springfield, Illinois, 1951.
5. Koons, R. D., Buscaglia, J., Bottrell, M., and Miller, E. T. Forensic glass comparisons. In: Forensic Science Handbook
6. Stoney, D. A. and Thornton, J. I. The forensic significance of the correlation of density and refractive index in glass evidence, Forensic Science International (1985) 29:147-157.
7. Elemental Analysis of Glass Fragments by ICP-MS as Evidence of Association: Analysis of a Case, Shirly Montero et al, J Forensic Sci, September 2003, Vol. 48, No. 5
8. Forensic Glass Analysis by LA-ICP-MS: Assessing the Feasibility of Correlating Windshield Composition and Supplier. Abbegayle J. Dodds, Edward M. Pollock, and Donald P. Land, Report submitted to the U.S. Department of Justice

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FOR/MJ/600BT	Disc and Cloud Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of disc and cloud forensics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of disc forensics
- Students will learn and analyze the file systems and data storage
- Students will have an understanding of the storage of cloud
- Students will understand the analysis of cloud forensics
- Students will learn the cloud forensic ecosystem

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe disc and cloud forensics
- CO2: Apply various scientific techniques in the analysis of storage
- CO3: Analyze and retrieve data from the clouds
- CO4: Compare various tools for cloud forensics
- CO5: Analyze cloud forensics ecosystem

Unit	Course Content	Contact Hours
Unit-I	**Introduction to disc forensics** • Definition and scope of disc forensics • The digital forensics process (Acquisition, Analysis, Reporting) • Legal and Ethical Considerations • Introduction to disc storage concepts • File systems and data storage: o Understanding different file systems (NTFS, FAT, EXT) o Data structures and File Allocation Methods o Disk Imaging Techniques (Write-blockers, Forensic Imaging)	09
Unit-II	**Digital evidence acquisition** • Write-Blocking Procedures • Disk Imaging Tools and Best Practices • Handling and Documentation of Evidence • Disk Analysis Techniques: o File System Carving and Data Recovery Techniques o Recovering Deleted Files and Metadata	09

	○ Analyzing Unallocated Space and Slack Space Artifacts • Disk Forensics Tools: ○ Introduction to Open-Source and Commercial Forensics Tools (e.g., Autopsy, FTK Imager) ○ Utilizing Tools for File System Analysis and Data Recovery ○ Understanding Features and Functionalities of Forensics Software)	
Unit-III	**Introduction to Cloud Forensics** • Cloud Computing Fundamentals (IaaS, PaaS, SaaS Models) • Understanding Cloud Storage and Data Distribution • Challenges and Considerations for Cloud Forensics • Legal and Regulatory Landscape (e.g., Electronic Discovery, Cloud Service Agreements) • Cloud Forensics Process: ○ Digital Forensics Principles Applied to the Cloud ○ Cloud Forensics Investigation Workflow (Identification, Preservation, Collection, Analysis) ○ Chain of Custody in the Cloud Environment	09
Unit-IV	**Cloud Evidence Identification and Preservation** • Identifying Potential Cloud-Based Evidence Sources (Logs, User Activity, Virtual Machines) • Cloud Provider APIs and Legal Mechanisms for Evidence Preservation • Techniques for Preserving Cloud Evidence (Static vs. Dynamic Data)	09
Unit-V	**Cloud Forensics tools and techniques** • Introduction to Cloud Forensics Tools (e.g., CloudXplorer, EnCase Cloud) • Utilizing Tools for Cloud Data Acquisition from Major Providers (AWS, Azure, GCP) • Analyzing Cloud Logs and Artifacts (Identifying Anomalies, User Activity)	09

Suggested Readings/Reference Books:

1. File System Forensic Analysis by Brian Carrier
2. Digital Forensics and Investigation by Eoghan Casey
3. Computer Forensics with Open-Source Tools by Harlan Carvey
4. Cloud Forensics: Theory and Practice by Jack Zhang et al.
5. Security, Privacy, and Digital Forensics in the Cloud by Chuck Howell and Brian Rumble

6. Cloud Forensics Demystified: Decoding cloud investigation complexities for digital forensic professionals by Rick Ayers et al.

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FOR/MJ/600CT	Botanical Evidence and Environmental Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers botanical evidence, diatoms, and plant poisons. It also covers environmental considerations in forensics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the plant-biology
- Students will learn and analyze the botanical evidence
- Students will have an understanding of diatoms and pollens
- Students will understand the analysis of plant poisons
- Students will learn the environmental aspects in forensics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe various botanical evidence
- CO2: Apply various scientific techniques in the analysis of botanical evidence
- CO3: Analyze diatoms and pollens
- CO4: Compare properties of plant poisons
- CO5: Analyze various environmental issues in forensics

Unit	Course Content	Contact Hours
Unit-I	**Plant Biology** • Introduction, Basic Plant Biology- plant cell structure and function, Gymnosperm and Angiosperm, Essential parts of plants, modes of plant reproduction, Importance of botanical evidence in forensic investigation, location, collection, preservation, and evaluation	09
Unit-II	**Botanical evidence** • Botanical evidence: Introduction, types, location, collection, identification, and/or evaluation and its forensic significance. • Fungi and plants; Pollens; Seeds and spores; Fibres; Wood; Leaves.	09
Unit-III	**Diatoms in drowning cases** • Ante-mortem and post-mortem drowning • Diatom and its types, morphology of Diatoms, methods of isolation, identification, and comparison, and their forensic importance significance.	09

Unit-IV	**Plant poisons and their lethality** • Common poisonous plants and types of plant toxins. Poisonous plants- (Classification, active constituent, lethality, and effects) *Abrus Precatorius, Argemone Mexicana, Calotropis, Atropa belladonna, Gloriosa Superba, Jatropha Curcas, Nerium Indicum, Nicotiana Tabacum, Ricinus Communis*. Types of plants yielding drugs of abuse – opium, cannabis, coco, tobacco, Dhatura, Psilocybin mushrooms.	**09**
Unit-V	**Environment and ecosystems** • Xenobiotic and recalcitrance, Bioremediation using microorganisms and plants, Genetically Modified Organisms to treat effluents; Introduction to BOD and COD, use of biosensors. Environmental Management Introduction and scope of environmental management, basic concepts of sustainable development, Environmental Impact Assessment.	**09**

Suggested Readings/Reference Books:

1. Timber Identification, N. Clifford; Leonard Hill Ltd.,
2. A manual of wood identification, Herbert L. Edlin Viking Press,
3. Man-made fibres, R.W. Moncrieff Newness butter worth
4. Identification of vegetable fibers, Dorothy Catling and John Grayson Chapman and Hall Ltd.
5. Pollen morphology & Plant taxonomy: angiosperms (an introduction to palynology), Erdtman, G Hafner Publishing Co.,
6. Forensic botany, Coyle, Heather Miller CRC Press,
7. College botany, Gangulee, Hirendra Chandra New Central Book Agency,
8. Plant anatomy, Esau, Katherine Wiley Eastern Ltd,
9. Plant anatomy, Chandurkar, P J Oxford & IBH Publishing Co,
10. Systematic botany for degree students, Singh, Jagjit S Chand & Co.,
11. The poisonous plants, H.C. Long Asiatic Publishing House,
12. Plant Anatomy, B.P. Pandey S. Chand and Co., New Delhi, (1998)
13. Environmental Law- The Law & policy relating to the protection of the environment, Ball Simon Universal Law Pub Co, Delhi,
14. Environmental Forensic Principles and Applications, Morrison Robert D, CRC Press, NY

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FOR/MJ/600DT	Forensic Chemistry of Fire and Explosive	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of fire, arson, and explosives. It also covers the forensic investigation and laboratory analysis of fire and explosion debris.

Course Objectives

The course has the following objectives:

- Students will gain an idea of various aspects of fire and explosive
- Students will learn and analyze petroleum products
- Students will have an understanding of the explosion scene investigation
- Students will understand the analysis of fire and explosion debris
- Students will learn the interpretation of analytical results

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the properties of various fire and explosive
- CO2: Apply various scientific techniques in the analysis of debris related to fire
- CO3: Analyze evidence related to explosive
- CO4: Compare properties of various explosives
- CO5: Interpretation of analytical results

Unit	Course Content	Contact Hours
Unit-I	**General Terminology of Fire** • Definition of fire, Flame and its types, Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron; Backdraft, Thermo-chemistry of Fire, Heat Capacity and Phase changes, Accelerants & types of accelerants, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapor density, vapor pressure, Fire extinguisher and its types.	09
Unit-II	**Arson and its investigation** • Legal Definition, motives of arson, Degrees of Arson, material and chemicals used in initiating arson, determining origin and cause; Fire patterns, Investigation of the fire-related crime scene, collection/ preservation of Arson Evidence, Flashover, Back draught, Documenting the fire or crime scene • Scheme of analysis: Extraction of samples from debris (Direct and solvent extraction methods, Head Space method, SPME, Distillation), Clean-up	09

	(Filtration & Acid stripping), Analysis (GC, GC-MS, FTIR & SEM etc.), Interpretation of GC-MS and other spectra	
Unit-III	**Petroleum products** • Introduction to Petroleum Products, Properties and Testing of Petroleum and Petroleum Products, Adulteration of petroleum products as per prevention of Malpractices in Supply and Distribution, Analysis of Dyes used in petroleum products, Chemical fingerprinting of petroleum products • Analysis of petroleum products as per BIS standards and ASTM specifications ○ Analysis of petrol, kerosene, diesel and Aviation Turbine Fuel as per BIS standards and ASTM specifications- Distillation, density, viscosity, surface tension, color, fluorescence, cloud point, pour point, aniline point, smoke point, boiling point, optical properties, flash point, refractive index and calorific value.	**09**
Unit-IV	**Explosive** • Definition of Explosives, Definition as per Indian Explosive Acts, History of Explosives, Chemistry of explosives, Deflagration and Detonation phenomenon (Redox Chemistry, Kinetics, Molecular Theory of gases & Gas Laws), Characteristics of high and low explosives, Dust explosion, Gas/vapor explosion, BLEVE, Effect of blast wave on structures & human and Pyrotechnics. • Improvised Explosive Device: Definition of IED, Components of IED, Explosives Initiation (Explosive Trains); Types (Molotov cocktail, Letter bomb, Pipe bomb, VBIED and CBRN), Detection of Hidden Explosives.	**09**
Unit-V	**Explosion and its analysis** • Bomb Scene: Specific approach to scene of explosion, Reconstruction of sequence of events, Evaluation and assessment of scene of explosion, • Analysis of Explosive: Pre-blast and Post blast residue collection, Systematic examination of explosives and explosion residues in the laboratory using chemical and instrumental techniques and interpretation of results.	**09**

Suggested Readings/Reference Books:

1. Kenyon Evans-Nguyen, Katherine Hutches - Forensic Analysis of Fire Debris and Explosives; Springer Publications, ISBN 978-3-030-25834-4, 2019
2. Eric Stauffer, Julia Dolan, Reta Newman – Fire Debris Analysis; Elsevier Publications, ISBN: 978-0-12-663971-1, 2008
3. Alexander Beveridge. Forensic Investigation of Explosives, CRC Press, 2nd edition, 2011
4. Explosive Substances Act, 1908
5. J. Akhavan. The Chemistry of explosives, RSC Publishing, 2015
6. J. Yinon, S. Zitrin. Modern Methods and Applications in Analysis of Explosives, Wiley Publishers 1996
7. Maurice Marshall, Jimmie Oxley, Aspects of Explosives Detection; Elsevier Publications, ISBN: 978-0-12-374533-0, 2009
8. Paul R. Laska, Bombs, IEDs, and Explosives: Identification, Investigation, and Disposal Techniques; CRC Press, Taylor & Francis Group, ISBN: 978-1-4987-1450-1, 2016
9. "Working Procedure Manual on Chemistry", Directorate of Forensic Science MHA Govt. of India, 2005.
10. "Laboratory Procedure Manual: Petroleum Products", Directorate of Forensic Science, MHA, Govt. of India, 2005.
11. Bureau of Indian Standard Specifications related to Alcohols and Petroleum Products.
12. Ret Newman, Micheal Gilbert, Kevin Lothridge: GC-MS Guide to Ignitable Liquids, CRC Press, LLC, 1999.
13. Beveridge, A: Forensic Investigation of Explosives, Taylor & Francis, 2000.
14. Yallop, H. J: Explosion Investigation, Forensic Science Society & Scottish Academic Press, 1980
15. An Introduction to Physics and chemistry of Petroleum
16. Kinghorn: Introduction to Petrochemicals Sukumar Maiti
17. D.W.Waples : Geochemistry in Petroleum Exploration
18. A.L.Waddams : Petroleum Geochemistry and Geology Chemicals from Petroleum
19. Saferstien: Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA
20. J A Siegel, P J Saukko (2000) Encyclopedia of Forensic Sciences Vol. I, II and III, Acad. Press.

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FOR/MJ/600ET	Printed Documents and Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of the examination of printed documents.

Course Objectives

The course has the following objectives:

- Students will gain an idea of various aspects of paper, ink, and printing technologies
- Students will learn and analyze the paper and ink examination
- Students will have an understanding of the printing technologies
- Students will understand the analysis of typewritten and photocopied documents
- Students will learn the concepts of digital printers

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe aspects of examination of printed documents
- CO2: Apply various scientific techniques in the analysis of paper and ink
- CO3: Analyze the printed technologies
- CO4: Compare various tools for typewritten and photocopied documents
- CO5: Analyze printed documents by the digital printers

Unit	Course Content	Contact Hours
Unit-I	**Paper and its examination** • Introduction to paper, types of paper, basic components of paper, plant tissue: vascular and ground, types of wood: hard and soft wood, cellulose: alpha and beta, hemicelluloses, lignin, polysaccharides, etc. • Paper making process: history of paper making, raw materials, pulping: introduction, methods of pulping, mechanical pulping, chemical pulping, pulp bleaching, pressing, drawing and sheet formation process, chemical treatment. • Forensic examination of paper: physical properties of paper: size, color, thickness, optical, porosity, pore size distribution, gas permeability, wetting and penetration of liquids, thermal, watermark and wire marks, microscopic examination: color reaction to different fibers, Herzberg staining, and Graff-C stain. • Paper aging and environmental effect on paper: humidity, chemical degradation, oxidation reaction to polysaccharides, cellulose, and lignin.	09
Unit-II	**Ink and its examination**	

	• Introduction to ink, history of ink, types of ink: nigrosine ink, logwood ink, iron nut gall ink, fountain pen ink, ball pen ink, gel pen ink, printing inks. Chemical ingredients of ink: vehicle, binder, colorant and additives (humectant, surfactant, anti-foaming agent, anti-bacterial, pH modifier, and others). Ink formulation. • Ink analysis: introduction, preliminary examination, ink color assessment, pen line microscopy, microscopic specular reflectance, video spectral analysis, identification and comparison of ink by spectroscopic (UV Visible, FTIR, Raman spectroscopy, Mass spectroscopy and laser induced fluorescence methods) and chromatographic (TLC, HPTLC, and HPLC) methods. • Ink aging or dating: first date production method, ink tag method, relative age comparison method, R-ratio method, p-extraction method, dye ratio method. Admissibility of report on ink dating in court.	09
Unit-III	**Printing Technologies** • History and Introduction of Industrial Printing. Principle and Mechanism of: Offset Lithography, Letterpress, Flexography, Gravure Printing, Screen Printing, Engraving, Thermography, Reprography. • Security Printing Techniques: Holograms, UV Visible Printing, Rainbow Printing, Microprinting, Guilloche, Line Printing, Embossing, UV Thread, Bar Coding. • Analysis of Printed Matters: Visual and Microscopic Examination, Thermal Methods: DSC, TGA, DTA, Instrumental: HPLC, XRD, SEM, TEM, STEM, AFM, etc.	09
Unit-IV	**Examination of typewriter and photocopier** • Typewriters: History and Introduction of Typewriters, Mechanism of typewriting, Types of crimes including typewriters, Forensic Examination of Typewritten matter: Visual, Microscopic and Examination of Ink. • Photocopier: History of xerography, components, and working process of the photocopier. Kinds of forgery by photocopy, inquiry related to photocopy, forensic examination of photocopier and photocopied documents	09
Unit-V	**Examination of digital printers and printed documents** • Introduction and history of digital printer, types of printers, Impact and Nonimpact printing technologies: dot matrix printer, daisy wheel, ink jet	09

	continuous and drop on demand (DOD), thermal, laser printer, etc., • Components and working mechanism of Dot matrix Printer, Inkjet printer, Laser printer, and Variable Data Printers. • Forensic examination of dot matrix, inkjet, laser. • Forensic examination of printed documents	

Suggested Readings/Reference Books:

1. Ellen, D (1997): The scientific examination of Documents, Methods and techniques. 2nd ed., Taylor & Francis Ltd.
2. Morris (2000) : Forensic Handwriting Identification (Fundamental Concepts and Principals)
3. Harrison, W.R.: Suspect Documents & their Scientific Examination, 1966, Sweet & Maxwell Ltd., London.
4. Hilton, O: The Scientific Examination of Questioned Document, 1982, Elsevier North Holland Inc., New York.
5. Sulner, H.F.: Disputed Document, 1966 Oceana Publications Inc., New York.
6. Saxena's: Saxena's Law & Techniques Relating to Finger Prints, Foot Prints & Detection of Forgery, Central Law Agency, Allahabad (Ed. A.K. Singla).
7. Quirke, A.J.: Forged, Anonymous & Suspect Documents, 1930, Reorge Rontledge & Sons Ltd., London.
8. Osborn, A. S.: Questioned Documents 1929, Boyd Printing Co., Chicago.
9. Levinson, J: Questioned Documents, 2000, Academic Press, Tokyo.
10. Kelly, J.S and Lindblom, B.S: Scientific Examination of Questioned Documents, 2006, Taylor & Francis, New York.
11. Brunelle, R.L. and Reed, R.W: Forensic Examination of Ink and Paper, 1984, Charles C Thomas Publisher, U.S.A.
12. Baker, J.N: Law of Disputed and Forged Documents, 1955, The Michie Company, Virginia.

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FOR/MJ/600P	Practical based on FOR/MJ/600T	Credit:03	Contact Hours:45	Marks:75

Course Overview

The practical course is based on the corresponding theory courses. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/600AP	Practical based on FOR/MJ/600AT	01	30	50
		OR			
2	FOR/MJ/600BP	Practical based on FOR/MJ/600BT	01	30	50
		OR			
3	FOR/MJ/600CP	Practical based on FOR/MJ/600CT	01	30	50
		OR			
4	FOR/MJ/600DP	Practical based on FOR/MJ/600DT	01	30	50
		OR			
5	FOR/MJ/600EP	Practical based on FOR/MJ/600ET	01	30	50

FOR/MJ/600AP	Practical based on FOR/MJ/600AT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Examination of Physical Evidence** (FOR/MJ/600AT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Comparison of glass samples on the basis of appearance, color, fluorescence, surface features, edge thickness, curvature and physical fit.
2. Density measurements of bigger fragments of glass.
3. Density comparison of glass samples by density gradient tubes.
4. Density comparison of glass samples by flotation method.
5. Refractive Index measurement of glass by immersion method.
6. Refractive index of glass using hot stage microscope.
7. Elemental analysis of glass evidences.
8. Microscopic examination of soil.
9. Ignition test for soil.
10. pH measurement of soil samples.
11. Particle Size Distribution of soil samples.
12. Density distribution of soil particles.
13. Examination of soil samples using X-Ray Diffraction.

14. Testing cement sample for adulteration.
15. Examination of cement on the basis test of cement.
16. Examination of cement on the basis of Ignition test.
17. Examination and identification of adulterated cement using X-Ray Diffraction.
18. Microscopic examination of paint samples.
19. Examination of textile fiber on the basis of microscopic properties.
20. Examination of textile fiber on the basis of chemical properties of dye using TLC.
21. Examination of paint samples on the basis of Microchemical test.
22. Examination of automotive Paint samples using Fourier Transform Infrared Spectroscopy.
23. Examination of broken objects on the basis of physical fit.
24. Examination of electric wires on the basis of electrical resistivity and microstructure.
25. Calibration of electrical energy meter and electricity audit calculation of appliances.
26. Examination of electric energy meters and find out the possible tampering mechanism adopted by the criminal.
27. Restoration of serial numbers on various metal surfaces using appropriate chemical method.
28. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/600BP	Practical based on FOR/MJ/600BT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Disc and Cloud Forensics** (FOR/MJ/600BT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Setting Up a Disk Forensics Workstation
2. Familiarization with Disk Imaging Tools (e.g., FTK Imager, Guymager)
3. Introduction to Open-Source Forensics Tools (e.g., Autopsy)
4. Write-blocking techniques using Hardware and Software Tools
5. Forensic Disk Imaging of a Target Drive
6. Verifying Disk Image Integrity (Hashing)
7. Exploring File Systems - Understanding File System Structures (NTFS, FAT, EXT)
8. Analyzing Disk Images with Forensic Software
9. Data Carving - Recovering Deleted Files and Unallocated Space Artifacts
10. Analyzing Deleted Internet History and Cached Data
11. Creating Forensic Reports - Documenting Acquisition, Analysis, and Findings
12. Familiarization with Cloud Forensics Tools (e.g., CloudXplorer, EnCase Cloud)
13. Exploring Cloud Provider Platforms (AWS, Azure, GCP) - Web Interfaces and APIs (Optional)
14. Identifying Potential Cloud Evidence Sources (Logs, User Activity, Virtual Machines)
15. Cloud Forensics and Chain of Custody in the Cloud Environment
16. Analyzing Cloud Logs - Identifying Anomalies, User Activity, and Indicators of Compromise
17. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/600CP	Practical based on FOR/MJ/600CT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Botanical Evidence and Environmental Forensics** (FOR/MJ/600CT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Identification of wood using physical and anatomical features.
2. Identification and classification of diatoms.
3. Examination of hair of different animals as cat, dog, cow, horse and goat.
4. Identification of pollen grains to genus level
5. Identification of starch granules.
6. Staining techniques and laboratory exercises for the identification of different plant cell types.
7. Microscopy of various plants fibres.
8. Differentiation of fibres including sisal, manila, jute, and cotton based on ashing.
9. Microscopic examination of man-made fibers.
10. Section and cutting of plant material and their examination.
11. Stepwise method for collection of botanical evidence
12. Collection and processing of algal evidence in forensic investigation
13. Visit to any of these: Autopsy centre at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Centre, Zoo, Biodiversity and Wildlife Centre
14. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/600DP	**Practical based on FOR/MJ/600DT**	**Credit:01**	**Contact Hours:30**	**Marks:50**

Course Overview

This is a laboratory course based on **Forensic Chemistry of Fire and Explosive** (FOR/MJ/600DT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Examinations of petrol as per BIS/ASTM specifications
2. Examinations of diesel as per BIS/ASTM specifications
3. Examinations of kerosene as per BIS/ASTM specifications
4. Identification of adulteration in petroleum product by TLC **(minimum two)**
5. Collection and analysis of explosion residues by spot test
6. Analysis of explosion residues by HPLC, TLC, GC, FT-IR (at least one from each of the techniques)
7. Extraction and analysis fire debris by color test methods **(minimum two)**
8. Extraction and Analysis of petrol from fire debris by GC, UV-visible and TLC **(at least one from each of the techniques)**
9. Extraction and Analysis of diesel from fire debris by GC and TLC **(at least one from each of the techniques)**
10. Extraction and Analysis of kerosene from fire debris by GC, UV-Visble and TLC **(at least one from each of the techniques)**
11. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/600EP	Practical based on FOR/MJ/600ET	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Printed Documents and Forensics** (FOR/MJ/600ET). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To make pulp for paper sheet formation through Kraft method.
2. Preparation of paper sheet through recycled paper.
3. Identification and detection of different types of ink through instrumental techniques.
4. Microscopic examination of ball-point pen inks
5. Microscopic examination of gel pen inks
6. Microscopic examination of fountain pen inks
7. Instrumental analysis of various inks
8. Examination of documents printed through laser printers
9. Examination of documents printed through inkjet printers
10. Examination of documents printed through thermal printers
11. Examination of documents printed through dot-matrix printers
12. Identification of source of photocopier machine by the examination of photocopied documents.
13. Identification of different types of printing technology on documents.
14. Identification and detection of type written matter on documents.
15. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/601T	Special Paper-II	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course has been designed to get the students specialized in a particular domain of forensic science. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/601AT	Motor Vehicle Crimes and Accident Analysis	03	45	75
		OR			
2	FOR/MJ/601BT	Digital Forensics and Incident Response	03	45	75
		OR			
3	FOR/MJ/601CT	Cellular Division, Regulation and Communication	03	45	75
		OR			
4	FOR/MJ/601DT	Forensic Toxicology-I	03	45	75
		OR			
5	FOR/MJ/601ET	Advanced Handwriting Examination	03	45	75

FOR/MJ/601AT	Motor Vehicle Crimes and Accident Analysis	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of motor vehicle components, accidents, and forensic analysis.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the various components of the vehicle
- Students will learn and analyze the vehicle and their components
- Students will have an understanding of the collection methods of evidence
- Students will understand the examination of the vehicle
- Students will learn the reconstruction of vehicular crime scene

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe the various components of the vehicle and accident analysis
- CO2: Apply various scientific techniques in the analysis of vehicle
- CO3: Analyze various evidence related to vehicular accidents
- CO4: Compare various scenarios in vehicular accidents

- CO5: Reconstruct vehicular crime scene

Unit	Course Content	Contact Hours
Unit-I	**Understanding the vehicle** • Overview of exterior and interior body parts of various vehicles; Introduction to: Steering system, suspension system, braking system, chassis and chassis numbers, wheels and tyres; Automotive engines: Types and general technical specifications (manufacturer, type, bore, stroke, capacity, compression ratio, valve gear, engine control, maximum power, maximum torque, fuel tank capacity etc.) of various vehicles and their relevance; Vehicle Identification Number (VIN) locations, engine number and RTO registration number, relevant vehicle documents.	09
Unit-II	**Motor vehicle crimes-I** • Crimes and vehicles, theft of vehicles, abandoned vehicles, vehicles involved in terrorism/ explosion, road accidents and main contributing factors **(equipment failure, roadway design, poor roadway maintenance, driver behaviours),** motor vehicle fire (exterior and interior examination, fuel tank/capacity examination, electrical systems, collection of fire evidence, evidence containers). Evidentiary clues: Vehicle, scene, culprit/victim, eyewitnesses.	09
Unit-III	**Motor vehicle crimes-II** Procurement/collection and evaluation of: Tyre marks/skid marks, tyre residue, tyre burst, scratch marks, head/tail light and other fragments, bulbs and filaments, glass fragments, blood, hairs, fabric, finger prints/foot marks, paint samples, vehicle registration and insurance related documents, engine number, VIN (constitution, decoding and interpretation), scene photographs and plans. Tyre evidence: Original equipment tyres, replacement tyres and tyre construction, tread nomenclature and side wall information, noise treatment, tread wear indicators, retread tyres. Tire track evidence: Stance, wheelbase, turning diameter, tire position in turn.	09
Unit-IV	**Vehicle examination** • Vehicle identification, examination of vehicle licence plate, examination of vehicle documents, Restoration of VIN/serial numbers, anti-theft systems, examination of steering columns and ignition locks, examination of vehicle keys, examination of burnt	09

	vehicles, examination of vehicles recovered underwater.	
Unit-V	**Vehicular accident reconstruction** • Inspection techniques, types of vehicle collision (head-on collisions, front-to-back collisions and eccentric collisions). Application of Impulse-Momentum theory to Linear Central Impact, Oblique Central Impact and Eccentric Impact and Rotations. Application of Poisson impact theory to vehicular collisions. Simple falls of vehicles. Breaking efficiency (motor cycle and four-wheeler). Types of skid marks and evidential value, Estimation of speed from skid marks on plane, up/down-graded roads. Occupants' kinematics, biomechanics of injuries.	**09**

Suggested Readings/Reference Books:

1. Automobile Engineering, R.B. Gupta, Satya Prakash, New Delhi.
2. Basic automobile engineering, C.P. Nakra, DhanpatRai Publication Company
3. Automotive Mechanics, N. K. Giri, 8th Edition, Khanna Publishers, New Delhi.
4. Automobile Engineering, Kripal Singh.
5. Forensic Examination of Stolen-Recovered and other crime related vehicles, Eric Staufer.
6. Forensic Science, An Introduction to Scientific and Investigative Techniques, 2nd Edition, Stuart H. James and Jan J. Nordby.
7. Forensic Engineering Fundamentals, Harold Franck and Darren Frank, CRC Press.
8. Encyclopaedia of Forensic Science Vol.1& 3, J A Siegel, Pekka J Saukko et al, Academic Press.
9. Highway Engineering,S K Khanna C E G Justo. Nem Chand and Bros, Roorkee, 2001.
10. Investigating automobile fire causes, Glen A. Shifflett, Journal of criminal law and criminology, 1958, volume 49, issue 3, article 14.
11. Automobile arson investigations, William J. Davis, Journal of criminal law and criminology, 1946, volume 37, issue 1, article 8.
12. Fire investigator: principles and practice, 4th edition, Jones and Bartlett
13. Application of Impulse Momentum Theory to Vehicle Collisions, A. G'uven "OZTAS, Tr. J. of Engineering and Environmental Science, 23 (1999) , 455 - 464.
14. Milan Batista, On the mutual coefficient of restitution in two car collinear collisions, 2006.
15. Website www.crashforensics.com, John C Glennon, Chartered.
16. Gardner, Ross M.; Practical Crime Scene Processing and Investigation, Boca Raton CRC Press (2005).
17. J.Walls; Forensic Science-An Introduction to Scientific Crime Detection 2nd Ed.,Universal, 1st Indian Reprint (2002).
18. Jay A.Siegel, Pekka J Saukko and Geoffrey C. Kooupfer; Encyclopedia of Forensic Science, Academic Pres s (2000).
19. Laboratory procedure manual, Forensic Physics, Director of Forensic Science (2005).
20. Nabar B. S.; Forensic science, Hyderabad Ashoka Law House (2005).
21. Richard Saferstein; Criminalistics-An Introduction to Forensic Science 5th Ed.,

Prentice Hall (1995).
22. Sharma, B R.; Forensic science in criminal investigation and trials, Allahabad Central Law Agency (1983).
23. Working Procedure Manual: Physics BPR&D Publication (2000).

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FOR/MJ/601BT	Digital Forensics and Incident Response	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of digital forensics and incident response.

Course Objectives

The course has the following objectives:

- Students will gain an idea of incident handling
- Students will learn and analyze the scene after the incident
- Students will have an understanding of the collection and forensic duplication
- Students will understand the storage and evidence handling
- Students will learn the incident response in a network

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe various terms of digital forensics and incident response
- CO2: Apply various methods for incident handling
- CO3: Analyze the incident for its better handling
- CO4: Compare various tools for incident response
- CO5: Analyze the network for recovering the incident traces

Unit	Course Content	Contact Hours
Unit-I	**Introduction to Incident Handling** • Computer Security Incident, Types of incidents, why necessary, Goals, Purpose, Organizational Roles, Incident Response Methodology Preparing for incident Response-Identifying Risk, Preparing Individual Hosts, Preparing Network, Establishing Appropriate Policies & Procedures, Creating Response Toolkit, Establishing an Incident Response Team	09
Unit-II	**After the Detection of the Incident** • Overview of incident response phases, documenting steps, stabling an incident notification procedure, Recording Details After Initial Detection, Conducting Interviews, Formulating a Response Strategy.	09
Unit-III	**Initial Response** • Initial Response & Volatile Data Collection from Windows system: Initial Response & Volatile Data Collection from Unix system. • Forensic Duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool	09

	Requirements, Creating a Forensic Duplicate/ Qualified Forensic Duplicate of a Hard Drive.	
Unit-IV	**Storage And Evidence Handling** • File Systems for window, Linux and Mac OS, Forensic Analysis of File Systems • Storage Fundamentals-Storage Layer, Hard Drives. • Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure.	**09**
Unit-V	**Network Forensics** • Collecting Network Based Evidence - Investigating Routers, Network Protocols - Email Tracing - Internet Fraud. Systems Investigation and Ethical Issues. • Data Analysis Techniques - Investigating Live Systems (Windows &Unix) - • Investigating Hacker Tools - Ethical Issues – Cybercrime. Report Writing Guidelines, A Template for Digital and Cyber Forensics report.	**09**

Suggested Readings/Reference Books:

1. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGrawHill, 2006.
2. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999.
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001.
4. Skoudis, E., Perlman, R. Counter Hack: "A Step-by-Step Guide to Computer Attack and Effective Defenses", .Prentice Hall Professional Technical Reference, 2001.
5. Norbert Zaenglein, "Disk Detective: Secret You Must Know to Recover Information From a Computer", Paladin Press, 2000.
6. Bill Nelson,Amelia Philips and Christopher Steuart, "Guide to computer forensics and investigations", course technology, Cengage Learning; 4thedition, ISBN: 1-435-49883-6, 2009.

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FOR/MJ/601CT	Cellular Division, Regulation and Communication	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers cellular structure, transport across membranes, cell division, cell cycle, and cellular communications.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the cellular division, regulations, and communications
- Students will learn the cell structure and their functions
- Students will have an understanding of cell division and programmed cell death
- Students will understand the cell cycle regulations
- Students will learn the cellular communications

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe various cellular processes
- CO2: Apply knowledge to understand transport across the membrane
- CO3: Analyze stages of cell division
- CO4: Interpret cell cycle regulations
- CO5: Evaluate various aspects of cellular communications

Unit	Course Content	Contact Hours
Unit-I	**Cellular Structure** • Definition of the cell, Diversity of cell size and shape, Structure of typical prokaryotic and Eukaryotic cells Organization, Structure and Functions of subcellular organelles, Structure & function of the cytoskeleton and its role in motility (actin, myosin, microtubules, and intermediate filaments).	09
Unit-II	**Transport across membrane** • Bilayer Fluid-mosaic model structure (Singer & Nicholson double-membrane model), • Transport across membrane: active vs passive transport.	09
Unit-III	**Cell division and Programmed cell death** • Mitotic and Meiotic division, Somatic vs. Germinal cells, Equational vs. reductional division, Stages of division, prophase, metaphase, anaphase, telophase, cytokinesis and their significance	09

	• Programmed cell-death: Apoptosis, Necrosis, cancerous growth.	
Unit-IV	**Cell cycle regulation** • Cyclins and Cyclin-dependent kinases (CDK's), Control and regulation of cell cycle. Oncogene, Proto-oncogene, Tumour-suppressor genes, Guard-gene, p53, Rb, p21, etc.	**09**
Unit-V	**Cellular Communication** • General principles of cell communication, cell-adhesion molecules and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, Neurotransmissions and its regulation, Steroidal hormones and their receptors, cell surface receptor, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.	**09**

Suggested Readings/Reference Books:

1. Copper Molecular Cell Biology
2. Alberts B et al Molecular biology of the cell. Garland Publishing Inc.
3. Lodish et al., Molecular cell biology. Freeman & company ,New York 1999
4. Gennis R.B Biomembranes- molecular structure and function. Springer.
5. G.Posil , S.T.Crooke (Eds) mechanism of receptor regulation. Plenum press.1985
6. DM Prescot: Reproduction in Eukaryotic cells, Academic Press
7. S.F Gilbert: Developmental Biology, Sinauer Associates Inc
8. Sheeler: cell and Molecular Biology.
9. Sadava ; cell biology

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FOR/MJ/601DT	Forensic Toxicology-I	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of forensic toxicology, poisons and their types, collection, extraction, isolation, and identification of various poisons.

Course Objectives

The course has the following objectives:

- Students will gain an idea of various forensic toxicology
- Students will learn and analyze various poisons
- Students will have an understanding of the extraction and isolation process
- Students will understand the analysis of volatile and non-volatile poisons
- Students will learn the interpretation of analytical results

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe the properties of various poisons
- CO2: Apply various scientific techniques in the analysis of volatile poisons
- CO3: Analyze evidence related to inorganic poisons
- CO4: Compare properties of various poisons
- CO5: Interpretation of analytical results

Unit	Course Content	Contact Hours
Unit-I	**Introduction to Forensic Toxicology** • Introduction and scope of Forensic Toxicology, History of forensic toxicology, classification of poisons: based on their origin, mode of action, and chemical nature; classification of poisoning: accidental, homicidal, suicidal, and miscellaneous, nature of poisons and poisoning in view of Indian scenario, sign and symptoms of various poisons and their antidotes, factors affecting poisoning, medico-legal aspects in poisoning.	09
Unit-II	**Collection and extraction process** • Collection, handling and preservation of viscera, blood, urine and other biological samples in poisoning cases, submission of samples into the laboratory, interpretation of toxicological findings and preparation of reports, limitation of methods and trouble shooting in toxicological analysis, disposal of unused samples pertaining to toxicological analysis.	09

	• Extraction: Introduction and fundamental principles of extraction, pre-conditions of extraction, types of extraction methods: liquid-liquid extraction, solid-phase extraction, and microextraction; Isolation and clean-up procedure.	
Unit-III	**Metal and its toxicity** • Metallic poisons: Nature, use, administration, symptoms, post-mortem findings, fatal dose, fatal period, detection, of metallic poisons including Lead, Copper, Mercury, Arsenic, Barium, Cadmium, Antimony, Thallium, etc. • Extraction and isolation of metallic poisons from various biological matrices by dry ashing, wet digestion and microwave digestion methods and their subsequent identification by Reinsch's test, Gutzeit Test and instrumental techniques.	**09**
Unit-IV	**Gaseous and volatile poison** • Introduction, nature, administration, signs and symptoms, fatal dose, fatal period, and postmortem appearance of the following: o Gaseous poisons: Carbon dioxide, phosgene, carbon monoxide, carbon disulfide, hydrogen sulfide, nitrogen monoxide, sulfur dioxide, war gases. o Volatile poisons: Acetone, ether, acetone, aniline, benzene, chloroform, camphor, chloral hydrate, carbon tetrachloride, ethyl alcohol, methyl alcohol, formaldehyde, phenol, acetaldehyde, isopropyl alcohol, hydrocyanic acid • Extraction of gaseous and volatile poisons from various biological matrices and their subsequent identification using color tests and instrumental techniques such as FT-IR, GC, GC-MS and tandem techniques.	**09**
Unit-V	**Non-volatile organic poison** • Classification, nature, fatal dose, fatal period, symptoms, post-mortem findings, medico-legal significance and analysis of Organo-phosphorous, Organochlorine, Carbamate and Pyrethroids insecticides and pesticides. • Extraction of non-volatile poisons from various biological matrices and their subsequent identification using color tests and instrumental techniques such as FT-IR, NMR, HPLC, LC-MS, GC, GC-MS and tandem techniques.	**09**

Suggested Readings/Reference Books:

1. Bamford F.; Poisons : Their Isolation and Identification, (3rd Edition); McGraw-Hill Press, 1955
2. Modi, Jaisingh, P.; Textbook of Medical Jurisprudence & Toxicology, M.M. Tripathi Publication (2001)
3. Clarke E.G.C. and Moffat A.C.; Clark's Isolation and Identification of Drugs (Edition 2 revised); Publisher Pharmaceutical Press. 1986
4. "Working Procedure Manual on Chemistry", Directorate of Forensic Science MHA Govt. of India, 2005.
5. Arena J.M. (3rd Edition) (1974), Poisoning: Toxicology, Symptoms treatments, Thomas: University of California.
6. Burcham Philip C (2013) ; An introduction to toxicology; 1st edition; Springer Publication; New York;
7. Christian Donell R (2004); Forensic Investigation Of Clandestine Investigation; 1st Edition; CRC Press; New York
8. Connors, K.A. (1975), A Text book of Pharmaceuticals analysis, Wiley Interscience, New York.
9. Curry A.S. (1972), Advances in Forensic and Clinical Toxicology, CRC Press.
10. Curry A.S. (Part II) (1986), Analytical Methods in Human Toxicology, Publisher Wiley Verlag Chemie.
11. Curry A.S. (Second Edition) (1969), Poison Detection in Human Organs, Springfield Thomas.
12. Dubois K.P. and Gelling E.M.K. (1959), Textbook of Toxicology, Oxford University Press.
13. Flanagan Robert J., Taylor A, Watson Ian D, Whelpton Robin (2008) ; Fundamental of analytic toxicology; 1st Edition; Wiley Blackwell; London
14. Hayes A Wallace, Kruger L. Claire; Haye's (2014): principles and methods of toxicology; 6th Edition; CRC Press; New York.
15. Hodgson Ernst (2011); A textbook of modern toxicology; 3rd Edition, John Wiley & Sons, Inc. Publication; Canada

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FOR/MJ/601ET	Advanced Handwriting Examination	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of the examination of printed documents.

Course Objectives

The course has the following objectives:

- Students will gain an idea of neuromuscular basis of handwriting and motor control
- Students will learn and analyze the various factors including neural abnormality which influence handwriting
- Students will have an understanding of various international standards for handwriting examination
- Students will understand the effect of neurological disease on handwriting
- Students will learn the principles of handwriting in its forensic examination

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe the concept of three-dimensional model of the nervous system and its functions in detail.
- CO2: Explain the models of handwriting motor control
- CO3: Identify different neurological diseases from signs and symptoms observed through handwriting
- CO4: Apply basic principle of handwriting for its examination and signature verification
- CO5: Interpret the effects of factors, like, neurological diseases, psychotropic medication, ageing and others on handwriting

Unit	Course Content	Contact Hours
Unit-I	**Neuromuscular Basis of Handwriting** • Human Nervous System, Broadman's area, Brain Function for Hand Motor Control, Neuroanatomical Bases of Hand Motor Control, Frontal-Subcortical Neural Circuits and Motor Function, The Cerebellum and Brain Stem, Handwriting as a Motor Program, Hierarchical Models of Handwriting Motor Control, Models of Handwriting Motor Control.	09
Unit-II	**Neural Abnormality and motor control** • Neurological disease and motor control: Parkinson's disease, Palsy and Corticobasal degeneration, Essential tremors, Multiple System atrophy, Multiple Sclerosis, Huntington's disease, Lower Moto neuron Disease, Alzheimer's disease. Psychotropic	09

	Medication and motor control. Aging and motor control.	
Unit-III	**Development of Handwriting** • History of Questioned Document Examination, Origin of Alphabet, Writing Systems (Indian, American, English, French, etc.), Development of Handwriting, Factors Affecting the Development of Handwriting, Basis of Handwriting Identification, Handwriting characteristics.	**09**
Unit-IV	**Factors influencing Handwriting** • Factors influencing handwriting: Different writing system, Physical Impedance, Neurological disease and handwriting, Effect of psychotropic medication on handwriting, Substance abuse and handwriting, Aging and Handwriting, Genetic Factors, Accidental, Circumstantial, deliberate.	**09**
Unit-V	**Handwriting/Signature Examination** • Handwriting examination: Understanding the objectives, Scope of handwriting examination, Sources of document examination, Forged and disguised handwriting, Science and art behind handwriting examination, Standard guidelines for handwriting analysis, Collection of specimens. • Signature: Process of evolving a signature, Signature forgery, Method of examination, Kinematics of signature authentication: Isochrony in genuine, simulated and forged signatures, stroke direction, etc.	**09**

Suggested Readings/Reference Books:

1. Caliguri M P and Mohammed LA, Neuroscience of Handwriting, CRC Press.
2. Huber, A. R. and Headrick, A.M. (1999): Handwriting identification: facts and fundamental CRC LLC
3. Ellen, D. (1997): The scientific examination of Documents, Methods and techniques. 2nd ed., Taylor & Francis Ltd.
4. Morris (2000): Forensic Handwriting Identification (fundamental concepts and Principals)
5. Harrison, W.R.: Suspect Documents & their Scientific Examination, 1966, Sweet & Maxwell Ltd., London.
6. Hilton, O: The Scientific Examination of Questioned Document, 1982, Elsaevier North Holland Inc., New York.
7. Sulner, H.F. : Disputed Document, 1966 Oceana Publications Inc., New York.
8. Saxena's: Saxena's Law & Techniques Relating to Finger Prints, Foot Prints & Detection of Forgery, Central Law Agency, Allahabd (Ed. A.K. Singla).
9. Quirke, A.J.: Forged, Anonymous & Suspet Documents, 1930, Reorge Rontledge & Sons Ltd., London.

10. Osborn, A. S.: Questioned Documents 1929, Boyd Printing Co., Chicago.
11. Levinson, J: Questioned Documents, 2000. Academic Press, Tokyo.
12. Kelly, J.S and Lindblom, B.S: Scientific Examination of Questioned Documents, 2006. Taylor & Francis, New York.

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FOR/MJ/601P	Practical based on FOR/MJ/601T	Credit:03	Contact Hours:45	Marks:75

Course Overview

The practical course is based on the corresponding theory courses. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/601AP	Practical based on FOR/MJ/601AT	01	30	50
		OR			
2	FOR/MJ/601BP	Practical based on FOR/MJ/601BT	01	30	50
		OR			
3	FOR/MJ/601CP	Practical based on FOR/MJ/601CT	01	30	50
		OR			
4	FOR/MJ/601DP	Practical based on FOR/MJ/601DT	01	30	50
		OR			
5	FOR/MJ/601EP	Practical based on FOR/MJ/601ET	01	30	50

FOR/MJ/601AP	Practical based on FOR/MJ/601AT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Motor Vehicle Crimes and Accident Analysis** (FOR/MJ/601AT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. VIN collection from various vehicles interpretation and authentication using check digit calculations.
2. Examination of the registration number plate and finding the owner of the vehicles.
3. Examination of the registration number plate and finding the type and other information of the various vehicles.
4. Photography of the accidental vehicle.
5. Documentation of a big accidental crime scene on busy highways using Photogrammetric techniques.
6. Determination of the age and pitch sequence of the various tires.
7. Examination and understanding of various road signs, signal and constructional features of the highways.
8. Examination of steering columns, braking system and ignition locks.
9. Determining the positions and severities of injuries to the occupants from the accidental velocity vector calculation in collision accidents.

10. Collecting Chassis numbers of various motor bikes and comparative study.
11. Comparative study of keys of various vehicles.
12. Examination of broken head/tail lights.
13. Examination of bulb filament.
14. Examination of driving licence/vehicle RTO registration/vehicle insurance documents.
15. Measurement of stance and wheelbase.
16. Tire sidewall information and interpretation.
17. To study class characteristics and wear and tear of various tyres.
18. Casting and evaluation of tyre impressions.
19. Measurement of turning diameter/radius of vehicle.
20. Measurement of peripheral vision.
21. Sample calculations of accident reconstructions.
22. Estimation of vehicle speed from skid lengths considering braking efficiency.
23. Analysis of simple fall of vehicles-sample calculations.
24. Physical examination of accidental vehicle-Visit to authorized auto garage.
25. Case study of vehicular accident.
26. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/601BP	Practical based on FOR/MJ/601BT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Digital Forensics and Incident Response** (FOR/MJ/601BT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Collection of volatile data from a window system
2. Collection of volatile data grom a Unix/Linux system
3. Collection of evidences from a network-connected system
4. Collection of evidences from routers
5. Making forensic copy of a hard disk/pen drive
6. Tracing the origin of an email
7. Analysis of live window system
8. Analysis of live Unix/Linux system
9. Analysis of live Macintosh system
10. Analysis of network log from a window system
11. Analysis of network log from Unix/Linux system
12. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/601CP	Practical based on FOR/MJ/601CT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Cellular Division, Regulation and Communication** (FOR/MJ/601CT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Microscopic study of mitotic stages.
2. Study of cellular morphology of different cells.
3. Study of transport across membrane: Diffusion, osmosis.
4. Study of different cellular organelle under microscope
5. Effect of detergents on membrane permeability
6. Isolation of cellular organelles
7. Study of marker enzymes from the isolated organelles.
8. Preparation of liposomes.
9. Preparation of Feulgen-Stained Chromosomes in root tip squashes
10. Effect of Colchicine on Chromosome movements during Mitosis.
11. Study of Immune Cells TLC/DLC
12. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/601DP	Practical based on FOR/MJ/601DT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Toxicology-I** (FOR/MJ/601DT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Extraction of toxic metal ions in given samples by Dry Ashing method, and analysis by color test
2. Extraction of toxic metal ions in given samples by wet digestion method, and analysis by color test
3. Analysis of Na+ and K+ contents in a soil sample by Flame Photometry
4. Determination of poisonous metals in biological matrices by AAS
5. Extraction and analysis of alcoholic residue from a given matrix
6. Extraction of a gaseous/volatile poison from viscera and analysis by color test, FT-IR and GC-MS **(at least one from each of the techniques)**
7. Extraction and analysis of organophosphorus pesticide using color test, TLC and UV-Visible spectrophotometer **(at least one from each of the techniques)**
8. Extraction and analysis of organo-chloro pesticide using color test, TLC and UV-Visible spectrophotometer **(at least one from each of the techniques)**
9. Extraction and analysis of carbamate using color test, TLC and UV-Visible spectrophotometer **(at least one from each of the techniques)**
10. Extraction and analysis of Pyrethroids using color test, TLC and UV-Visible spectrophotometer **(at least one from each of the techniques)**
11. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/601EP	Practical based on FOR/MJ/601ET	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Advanced Handwriting Examination** (FOR/MJ/601ET). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To study the CNS in view of handwriting
2. To perform examination of handwriting with the given samples
3. To perform examination of handwriting on various surfaces
4. To examine the effect of various posture on handwriting
5. To examine the effect of nuerological disease on handwriting
6. To examine the effect of emotions on handwriting
7. To examine handwriting influenced by age
8. To examine handwriting samples of a twin
9. To examine forged signatures
10. To examine simulated handwriting
11. To examine the handwriting numerals
12. To examine disguise in handwriting
13. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/602T	Special Paper-III	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course has been designed to get the students specialized in a particular domain of forensic science. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/602AT	Forensic Ballistics	03	45	75
		OR			
2	FOR/MJ/602BT	Network Forensics	03	45	75
		OR			
3	FOR/MJ/602CT	Molecular processes and their regulations	03	45	75
		OR			
4	FOR/MJ/602DT	Forensic Analysis of Drugs	03	45	75
		OR			
5	FOR/MJ/602ET	Foundation to Biometrics	03	45	75

FOR/MJ/602AT	Forensic Ballistics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of forensic ballistics

Course Objectives

The course has the following objectives:

- Students will gain an idea of the various components of the firearms
- Students will learn and analyze the firearms and ammunition
- Students will have an understanding of the collection methods of evidence
- Students will understand the arms-ammunition linkage
- Students will learn the aspects of wound ballistics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe the various components of firearms
- CO2: Apply various scientific techniques in the examination of firearms
- CO3: Analyze various ammunitions for their examination
- CO4: Compare various characteristics of evidence for the identification of firearms and ammunition
- CO5: Analyze concepts of wound ballistics

Unit	Course Content	Contact Hours
Unit-I	**Firearms** • Primitive, muzzle-loaded, modern firearms, shotgun: Shotgun family, barrel, choke and its types, chamber, action. Rifles: Barrel, twist, barrel calibre and length, action, magazine, stock, Indian rifles, assault rifles. Carbine, Revolvers: Barrel, action, solid frame, break frame, and side swinger revolvers, Pistols: Action, barrel, magazine. Machine Guns, Submachine guns Air Rifles and Air Pistols, Cattle Gun, Stud Guns, Caseless cartridge firearms, Pest guns, Improvised firearms, and Indian ordinance factory firearms.	09
Unit-II	**Ammunition and firing mechanism** • Propellants: Black, smokeless, semi-smokeless and triple-base powders, RDX based propellants. Projectiles: Lead, jacketed, non-lead, armour piercing, tracer, incendiary, boat-tailed and stream-lined bullets, spherical projectiles. Primers, cartridge cases (shells): Shotgun shell and brass shell. Wads, lubricants, fixed ammunitions: Shotgun cartridge, flechettes, rifle cartridge, revolver cartridge, pistol cartridge, blank cartridge, fifle grenade cartridge, consumable cartridge, duplex cartridge, firing mechanism	09
Unit-III	**Evidentiary clues and evaluation** • Location: Scene of occurrence, victim, culprit, firearm, ammunition. Collection: Firearm, cartridge case, bullet, slugs and shot, clothes, live ammunition, glass fragments, gun-shot residue, injuries, bullet marks and holes, test exhibits. Problems: Firearm, fired ammunition, medico-legal, muzzle-loaders, live ammunition. Acceptability: Relevancy, identity, purity, authenticity, chain of possession. Evidence charts: Evidence information chart, evidence collection log. Forwarding letter, laboratory work and report proforma.	09
Unit-IV	**Arm-ammunition linkage** • Arm-ammunition linkage: Principles, test exhibits, examination, range of fire, GSR (nature, location, detection, collection and evaluation), Injuries (Firearm injuries, shotgun injuries and rifled firearm injuries).	09
Unit-V	**Wound Ballistics** • Ballistic aspect of firearm injuries, Mechanism of firearm injuries (Lacerations and Shockwaves etc.),	09

	Threshold velocity for penetration of skin/flesh/bones, preparation of gel block, penetrative in gel block and other targets, Bullet Entry/Exit Hole Identification, Evaluation of Accident, Suicide, murder and self-defense firearm injuries, 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	

Suggested Readings/Reference Books:

1. Firearms in Criminal Investigation and Trials, 4th Edition, B. R. Sharma, Universal Law Publication, New Delhi.
2. Forensic Science in Criminal Investigation & Court Evidence, V.N. Sehgal, Selective & Scientific Books, New Delhi.
3. Handbook of Fire arm and ballistics, Brian J Heard.
4. Forensic ballistics in Criminal Justice, Kausalendra Kumar
5. Introduction to Forensic Science in Crime Investigation, Dr. Rukmani Krishnamurthy.
6. The world encyclopaedia of modern guns, A J R Cormack .
7. Firearm, the law, and Forensic Balllistics, Tom Warlow.
8. Fire Arms, Forensic Ballistics, Forensic Chemistry and Criminal Jurisprudence, S N Gaur et al.
9. Wiley Encyclopaedia of Forensic Science, Vol-5, Allan Jamieson and Andre Moenssens.
10. Encyclopaedia of Forensic Science Vol. 3, J A Siegel, Pekka J Saukko et al, Academic Press.
11. Forensic Science, An Introduction to Scientific and Investigative Techniques, 2nd Edition, Stuart H. James and Jan J. Nordby.
12. Techniques of Crime Scene Investigation. Barry A.J. Fisher.Seventh Edition.CRC Press.
13. The world Encyclopedia of Modern Guns, A.J.R. Cormack, Octopus Books Limited, London.
14. Working procedures Laboratory Manual (Physics Division), DFSL, Mumbai.
15. Tool Mark Comparisons in Criminal Investigations, David Q. Burd and Roger S. Greene, Journal of Criminal Law and Criminology, Volume 39 | Issue 3 Article 11

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FOR/MJ/602BT	Network Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of networks and network forensics

Course Objectives

The course has the following objectives:

- Students will gain an idea of various aspects of network forensics
- Students will learn and analyze intrusion prevention and detection
- Students will have an understanding of the various components of the network
- Students will understand the concept of network tunneling
- Students will learn the event logs and their analysis

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe various terms of network forensics
- CO2: Apply various methods for intrusion prevention and detection
- CO3: Analyze the incident through the event log analysis
- CO4: Compare various tools for network analysis
- CO5: Analyze the network tunnelling

Unit	Course Content	Contact Hours
Unit-I	**Fundamentals of Network Forensics** • Fundamentals of Network Forensics: Introduction, Definition, Classification of network forensics, Recent trends in network forensics, Challenges in network forensics. • Sources of Network-Based Evidence: Switches, Routers, DHCP server, Name servers, Authentication servers. • Packet Analysis: Protocol Analysis, Packet Analysis Tools, Packet Analysis Techniques, Flow Analysis, Higher-Layer Traffic Analysis, Case Studies, Sensors: Evidence collection through sensor, Case studies. • Wireless: Network Forensics Unplugged: The IEEE Layer 2 Protocol Series The 802.11 Protocol Suite, 802.1X, Wireless Access Points (WAPs), Why Investigate Wireless Access Points? Types of Wireless Access Points, WAP Evidence, Wireless Traffic Capture and Analysis, Spectrum Analysis, Wireless Passive Evidence Acquisition, analyzing 802.11 Efficiently, Common Attacks, Locating Wireless Devices.	09

Unit-II	**Network Intrusion Detection and Analysis:** • Introduction to Network Intrusion Detection System (NIDS)/ Network Intrusion Prevention System (NIPS) • Typical NIDS/NIPS Functionality: Sniffing, Higher-Layer Protocol Awareness, Alerting on Suspicious Bits, Modes of Detection: Signature-Based Analysis, Protocol Awareness, Behavioral Analysis, Types of NIDS/NIPSs: Commercial Roll-Your-Own, NIDS/NIPS Evidence Acquisition, Types of Evidence, NIDS/NIPS Interfaces, Comprehensive Packet Logging, Snort: Basic Architecture, Configuration, Snort Rule Language, Examples	**09**
Unit-III	**Event Log Aggregation, Correlation, and Analysis** • Sources of Logs: Operating System Logs, Application Logs, Physical Device Logs, Network Equipment Logs, Network Log Architecture, Three Types of Logging Architectures, Remote Logging: Common Pitfalls and Strategies, Log Aggregation and Analysis Tools, Collecting and Analyzing Evidence, Obtain Information, Strategize	**09**
Unit-IV	**Evidence in Networks** • Switches, Routers, and Firewalls: Types of Switches, Evidence in Switches, Types of Routers, Evidence in Routers, Types of Firewalls, Evidence in Firewall • Interfaces: Web Interface, Console Command-Line Interface (CLI), Remote Command-Line Interface, Simple Network Management Protocol (SNMP), Proprietary Interface, Logging, Local Logging, Simple Network Management Protocol, syslog, Authentication, Authorization, and Accounting Logging • Web Proxies: Web Proxy Functionality: Caching, URI Filtering, Content Filtering, Distributed Caching, Evidence, Types of Evidence, Obtaining Evidence, • Squid: Squid Configuration, Squid Access Logfile, Squid Cache, • Web Proxy Analysis: Web Proxy Log Analysis Tools, Example: Dissecting a Squid Disk Cache, • Encrypted Web Traffic: Transport Layer Security (TLS), Gaining Access to Encrypted Content, Commercial TLS/SSL Interception Tools	**09**
Unit-V	**Network Tunnelling** • Tunnelling for Functionality: Background: VLAN Trunking, Inter-Switch Link (ISL), Generic Routing Encapsulation (GRE), IPv6 over IPv4 with Teredo,	**09**

	Implications for the Investigator, Tunnelling for Confidentiality : Internet Protocol Security (IPsec), Transport Layer Security (TLS) and Secure Socket Layer (SSL), Implications for the Investigator ,Covert Tunnelling : Covert Tunnelling Strategies, TCP Sequence Numbers, DNS Tunnels, , ICMP Tunnels, Example: ICMP Tunnel Analysis, Implications for the Investigator, Case Studies.	

Suggested Readings/Reference Books:

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

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FOR/MJ/602CT	Molecular Processes and their Regulations	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of molecular processes and their regulations.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the DNA replication processes
- Students will learn the transcript and post-transcriptional modifications
- Students will have an understanding of genetic code and translation
- Students will understand the regulations of gene expression in procaryotic cells
- Students will learn the regulations of gene expression in eucaryotic cells

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe various terms related to DNA replications and gene expressions
- CO2: Apply knowledge to understand transcriptional and non-transcriptional modifications
- CO3: Analyze protein synthesis and genetic codes
- CO4: Compare regulations of gene expression in various cells
- CO5: Evaluate various aspects of molecular processes

Unit	Course Content	Contact Hours
Unit-I	**Replication** • Central dogma of molecular biology. Players of DNA replication, types of DNA polymerases and their properties, the process of DNA replication, genomic DNA replication, Circular and linear DNA replication in eukaryotes, multiple origins of replication eukaryotic chromosomes.	09
Unit-II	**Transcription and post-transcriptional modifications** • Transcription: terminologies- eukaryotic genome, cistrons, coding sequence & Open Reading Frame, RNA polymerases types & function. Activators, repressors, regulatory proteins; Transcription: control of transcription. Post-transcriptional modifications	09
Unit-III	**Genetic code & Translation** • Genetic code, Ribosomes, Secretory and non-secretory proteins. • Protein Synthesis: Initiation, elongation & termination of protein synthesis.	09

	• Protein folding: Chaperons and chaperonins • Protein localization and targeting: COP-II and COP-I pathway.	
Unit-IV	**Regulation of Gene Expression in Procaryotic cells** • Organization of genes: Operator, Promotor, structural genes, positive, negative control, Operons: *lac, ara, trp,* inducible, repressible, attenuation, anti-termination, lambda-phage circuit	**09**
Unit-V	**Regulation of Gene Expression in Eucaryotic cells** • Gene organization, DNA-protein interactions, motifs, activators, repressor, enhancer, silencer, global regulator	**09**

Suggested Readings/Reference Books:

1. Genetics a conceptual approach: Fourth edition by Benjamin Pierce.
2. An Introduction to Forensic Genetics: William Goodwin, Adrian Linacre, SibteHadi
3. Forensic DNA Typing: Biology, Technology, and Genetics behind STR Markers by John M. Butler
4. An Introduction to Forensic Genetics, (2007): Goodwin William, John Wiley & Sons Ltd,
5. Basic human genetics (1991) :Kapur V, Jaypee Brothers
6. Essentials of Human Genetics (2009): Kothari, Manu L, Universities Press (India) Pvt. Ltd.
7. Fundamentals of Genetics,(2006) :Singh, B.D., Kalyani Publishers
8. Genes IX,(2008): Lewin, Benjamin Jones and Bartlett Publishers
9. Genetic influences on neural and behavioral functions. (2000): Pfaff, Donald W CRC Press
10. Genetic Markers in Human Blood,(1969): Giblett, Eloise R. Blackwell Scientific Publications
11. Genetics, (2003): Winter, P.C; Viva Books Pvt. Ltd.,
12. Genetics Altenburg, (1970): Edgar, Oxford& IBH Publishing Co.
13. Genetics Strickberger, (2005): Monroe, Prentice Hall of India Ltd
14. Genetics, (1998): Hartl, Daniel L Jones and Bartlett Publishers
15. Genetics of populations,(2005):Hedrick, Philip W Jones and Bartlett publishers,
16. Genomic Imprinting, (1995): Ohlsson, R.; Cambridge University Press
17. Human Genetics, (1987): Vogel, Friedrich; Springer –Verlag Berlin Heidelberg,
18. Human Genome methods, (1998): Adolph, Kennetth W CRC Press,
19. Human population genetics in India,(1974): Sanghvi, L.D; Orient Longman Ltd,
20. Concepts of Genetics: Klug W.S. & Cummings M.R., Prentice-Hall
21. An Introduction to Genetic Analysis, Griffith A.F. et al., Freeman

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FOR/MJ/602DT	Forensic Analysis of Drugs	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of drugs and their analysis

Course Objectives

The course has the following objectives:

- Students will gain an idea of drugs of abuse
- Students will learn and analyze various drugs
- Students will have an understanding of the NDPS drugs
- Students will understand the analysis of clandestine laboratory
- Students will learn the drugs of abuse in sports

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe the drugs of abuse
- CO2: Apply various scientific techniques in the analysis of drugs
- CO3: Analyze evidence related to clandestine laboratories
- CO4: Compare properties of various drugs
- CO5: Interpretation of analytical results

Unit	Course Content	Contact Hours
Unit-I	**Introduction to Drugs of abuse** • Drug: Definition of Drug, Drug Use & Misuse, Drug Chemistry, Drug Dependence and chemistry of Addiction, Drug Receptors and Brain Chemistry • Drugs of abuse: Antidepressants, antipsychotics, antibiotics, tranquilizer: nature, extraction from viscera, blood, vomit; Fatal dose, fatal period, signs and symptoms, post-mortem findings, medico-legal significance and detection (preliminary and confirmatory tests)	09
Unit-II	**Narcotic Drugs and Psychotropic Substances** • Introduction, Classification, Nature, Fatal dose, fatal period, signs and symptoms, post-mortem findings, extraction from viscera, blood, vomit, urine etc. Medico-legal significance of stimulants, hallucinogens, barbiturates, depressants, cannabis, sedatives, Morphine, Codeine, Heroin, Cannabis Sativa and its derivatives, Cocaine, Mescaline, LSD • Legal provisions for NDPS drugs in India	09

Unit-III	**Clandestine Laboratory and its investigation** • Clandestine drug manufacture: lab operators, manufacturing process, clandestine lab need triangle. • Clandestine lab hazards: general hazards, priority hazards-explosions, fire, firearm, exposure; dealing with hazards at clandestine lab site. • Scene processing: training, seizure stages, planning, documentation, search, sampling, field testing, disposal • Lab analysis: inorganic and organic compounds-color tests, microscopic analysis, IR spectroscopy, Ion chromatography, X-ray, Mass spectroscopy, GC, HPLC.	**09**
Unit-IV	**Analysis of Drug** • Methods of extraction of drug (acidic, basic and neutral) from biological matrices such as blood, urine, saliva, vomit, viscera. • Preliminary analysis of drugs: Identification of drugs by spot tests, microcrystal tests, TLC and UV-Vis spectroscopy. • Confirmatory analysis of drugs: Quantification of drugs by FTIR, GC, HPLC, GC-MS, LC-MS/MS, NMR and XRD.	**09**
Unit-V	**Drug of Abuse in Sports** • Introduction, International Olympic Committee (IOC), World Anti-Doping Agency (WADA), classification of commonly prohibited substances and Performance enhancing Drugs, Steroids, Stack and Pyramid methods, Dope test and Blood Doping, Sampling techniques, analytical approaches.	**09**

Suggested Readings/Reference Books:

1. Clarke's Analysis of Drugs and Poisons: In Pharmaceuticals, Body Fluids and Postmortem Material, Pharmaceutical Press, 2011
2. Indian Pharmacopoeia 2014 with DVD - Seventh edition
3. Narcotic Drugs and Psychotropic Substances Act, 1985
4. Christian Donell R (2004); Forensic Investigation Of Clandestine Investigation; 1st Edition; CRC Press; New York
5. Klaassen, C. D.,:Casarett and Doull's Toxicology: The Basic Science of Poisons, 5th ed, McGraw-Hill, 1995.
6. Moffat, A.C. : Osselton, D. M. Widdop, B. : Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, body fluids and postmortem material, 3rd ed., Pharmaceutical Press, 2004.
7. Bogusz, M. J.,: Hand Book of Analytical Separations, Vol. 2: Forensic Science, 1st ed., Elsevier Science, 2000.
8. James, S. H. and Nordby, J. J.: Forensic Science: An Introduction to Scientific and Investigative Techniques, 2003.
9. Saferstein, R: Criminalistics - An Introduction to Forensic Science, Prentice Hall, 1995.
10. Eckert; An Introduction to Forensic Science, CRC Press

11. Pillay, V. V.; Handbook of Forensic Medicine and Toxicology, Paras Pub., 2001
12. Curry, A. S: Poison Detection in Human Organ
13. Olaf H. Drummer, Dimitri Gerostamoulos; Forensic Drug Analysis; Future Science Publisher, ISBN: 978-1-909453-37-1, 2013
14. Frederick P. Smith, Jay A. Siegel; Handbook of Forensic Drug Analysis; Elsevier Publications, ISBN 0-12-650641-8, 2005

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FOR/MJ/602ET	Foundation to Biometrics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of biometric examination, especially the foundation stones, including basic concepts of image analysis and biometrics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the basic concepts of image analysis
- Students will learn and analyze various learning algorithms
- Students will have an understanding of various biometrics
- Students will understand the details of fingerprint biometric
- Students will learn the details of signature biometric

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and describe the concept of image analysis, learning and recognition
- CO2: Explain the models of classification and clustering
- CO3: Apply algorithms for identification of signature and fingerprint biometric
- CO4: Compare various biometric traits of identification
- CO5: Construct the algorithms for biometric identification

Unit	Course Content	Contact Hours
Unit-I	**Fundamentals of Image Analysis** • Image: definition and types, digitization process: sampling and quantization, Image enhancement: spatial and frequency domain; edge detection techniques: Robert's, Prewitt, Sobel, Canny; introductory concept of image compression	09
Unit-II	**Features, Learning, and Recognition** • Basic concepts of features: shape, color, and texture; introduction to machine learning: supervised, unsupervised, and reinforced learning, classification techniques: Bayesian, linear, and non-linear, clustering methods: K-means clustering, Dimensionality reduction technique: PCA, LDA	09
Unit-III	**Introduction to biometrics** • Biometrics: Introduction, importance of other biometric traits in conjunction with fingerprint, steps involved in a generic biometric recognition system, physiological biometric traits: iris, hand geometry,	09

	face, retina scan, thermogram, behavioral biometrics: voice, signature, gait, keystroke dynamics	
Unit-IV	**Automated Fingerprint Identification System (AFIS)** • Introduction and history of AFIS, components and working mechanism of AFIS, Steps involved in automated fingerprint identification, Types of AFIS searches: Ten print to Ten print search, Latent to ten print searches, Latent to latent search. Enhancement of digitally captured fingerprints. ANSI-NIST standards for fingerprint transmission and compression. Indian fingerprint identification system: FACTS, AMBIS, NAFIS	**09**
Unit-V	**Signature/Handwriting Identification** • Automated framework for document examination: introduction and scope, the need of automation: Daubert's standard, NRC report, PCAST report, statistical validation of Individuality of handwriting, Automated system for handwriting and signature examination: steps involved, components and working. Some well-known systems for handwriting/signature identification: FISH, SCRIPT WANDA, CEDAR FOX, FLASH-ID.	**09**

Suggested Readings/Reference Books:

1. Digital Image Processing by Gonzalez and Woods
2. Digital Image Processing and Analysis by Chanda and Majumdar
3. Feature Extraction and Analysis by Mark Nixon
4. Digital Image Processing by Ionis Pitas
5. Digital Image Processing by Anil K Jain
6. Pattern Recognition by Theodoridus
7. Biometrics by Anil jain and salil Prabhakar
8. Automated Fingerprint Identification System by Peter Komarinski
9. Kelly,J.S and Lindblom, B.S: Scientific Examination of Questioned Documents, 2006, Taylor & Francis, New York.
10. Forensic Document Examination: Fundamentals and Current Trends By Jane A. LewisLevinson, J: Questioned Documents, 2000, Academic Press, Tokyo.
11. Kelly, J.S and Lindblom, B.S: Scientific Examination of Questioned Documents, 2006, Taylor & Francis, New York.

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FOR/MJ/602P	Practical based on FOR/MJ/602T	Credit:03	Contact Hours:45	Marks:75

Course Overview

The practical course is based on the corresponding theory courses. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/602AP	Practical based on FOR/MJ/602AT	01	30	50
		OR			
2	FOR/MJ/602BP	Practical based on FOR/MJ/602BT	01	30	50
		OR			
3	FOR/MJ/602CP	Practical based on FOR/MJ/602CT	01	30	50
		OR			
4	FOR/MJ/602DP	Practical based on FOR/MJ/602DT	01	30	50
		OR			
5	FOR/MJ/602EP	Practical based on FOR/MJ/602ET	01	30	50

FOR/MJ/602AP	Practical based on FOR/MJ/602AT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Ballistics** (FOR/MJ/602AT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. GSR analysis.
2. Restoration of marks/numbers on various surfaces.
3. To Study the caliber and rifling characteristics
4. Forensic Examination of firearm(s).
5. To study assembling and dismantling of firearms.
6. To study the working mechanism of firearm(s).
7. Forensic Examination of rifles.
8. Forensic Examination of shotguns.
9. Forensic Examination of country-made firearms (desi-katta).
10. Forensic Examination of ammunition.
11. Dismantling of shotgun cartridge.
12. Determination of shot number from size and weight of shots.
13. Physical examination of propellant of ammunition.
14. Examination of choking in shotgun.

15. Study of constructional features of improvised firearms.
16. To study proof mark of firearm.
17. Study of constructional features of cartridge.
18. Characteristics of Firearms Calibre, Choke, Triggerpull, Proofmarks etc.
19. Examination and Comparison of fired bullets Calibre, rifling characteristics, probable type of firearms
20. Examination and Comparison of fired Cartridges/cases (Calibre, firing pin, breech face, Extractor/Ejector marks etc.)
21. Determination of shot number from size and weight of shots.
22. Examination of air guns/rifles as per Arms Act 1959.
23. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/602BP	Practical based on FOR/MJ/602BT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Network Forensics** (FOR/MJ/602BT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Wireless Network attacks, Bluetooth attacks
2. Firewalls, Intrusion Detection and Honeypots
3. Malware – Keylogger, Trojans, Keylogger countermeasures
4. Understanding Data Packet Sniffers
5. Understanding the buffer overflow and format string attacks
6. Using NMAP for ports monitoring
7. Understanding SQL Injection
8. Working with Trojans, Backdoors and sniffer for monitoring network communication
9. Denial of Service and Session Hijacking using Tear Drop, DDOS attack.
10. Penetration Testing and justification of penetration testing through risk analysis
11. Implementing Web Data Extractor and Web site watcher.
12. Using IP TABLES on Linux and setting the filtering rules
13. Lan Scanner using look@LAN, wireshark.
14. Understanding DoS Attack Tools- Jolt2, Bubonic, Land and LaTierra, Targa, Nemesy Blast, Panther2, Crazy Pinger, Sometrouble, UDP Flood, FSMax.
15. Email header and URL analysis
16. Drive and partition carving process
17. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/602CP	Practical based on FOR/MJ/602CT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Molecular processes and their regulations** (FOR/MJ/602CT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Chromosome staining by Giemsa.
2. Polytene chromosome staining from salivary glands of Chironomus larvae
3. Preparation of Human Genomic DNA: Cell breakage, Removal of proteins, (Using organic solvents, using enzymes), Removal of RNA, Concentrating the DNA.
4. Determination of purity and quantity of DNA.
5. Problems on population genetics
6. Extraction of mitochondrial DNA from forensic samples
7. Isolation of Plasmid DNA & Transferring plasmid DNA into bacterial cell
8. Preparation and transformation of competent E. coli using calcium chloride
9. DNA detection method: fluorescent and silver staining
10. Demonstration of mutation on the basis of bacterial pigmentation
11. Detection of phenylketonuria
12. Visit: Mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Centre, Zoo, Biodiversity and wildlife Centre.
13. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/602DP	Practical based on FOR/MJ/602DT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Drug Analysis** (FOR/MJ/602DT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Extraction, Systematic identification of Narcotic Drugs and Psychotropic Substances (opiates, morphine, codeine, heroin, cannabis and amphetamines) by spot/color tests and TLC (**minimum four**)
2. Extraction and analysis of cannabinoids from Cannabis sativa by color test and TLC.
3. Analysis of cannabinoids from Cannabis Sativa using HPLC
4. Extraction of caffeine (stimulant) from beverages and its analysis by iodometry titration, TLC and HPLC (**at least one from each of the techniques**)
5. Extraction of drug from blood sample and subsequent analysis using TLC
6. Extraction of drug from blood sample and subsequent analysis using UV-Visible Spectrophotometer
7. Extraction of drug from blood sample and subsequent analysis using FTIR
8. Extraction of drug from urine sample and subsequent analysis using TLC
9. Extraction of drug from urine sample and subsequent analysis using UV-Visible Spectrophotometer
10. Extraction of drug from urine sample and subsequent analysis using FTIR
11. Extraction of drug from viscera sample and subsequent analysis using TLC
12. Extraction of drug from viscera sample and subsequent analysis using UV-Visible Spectrophotometer
13. Extraction of drug from viscera sample and subsequent analysis using FTIR
14. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/602EP	Practical based on FOR/MJ/602ET	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Foundation to Biometrics** (FOR/MJ/602ET). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To write a program for reading, writing, and displaying an image file
2. To write a program for displaying various components of a color image
3. To convert a color image to a gray-scale and binary image
4. To write a program for contrast stretching of the given image
5. To write a program for histogram equalization of the given image
6. To write a program for the mean filter of various mask sizes for the given image
7. To write a program for the median filter of various mask sizes for the given image
8. To write a program for implementing edge detection on the given image
9. To write a program for implementing PCA on the given data
10. To write a program for implementing NN classifier on the given data
11. To capture fingerprints through an online method
12. To work on AFIS to identify a given fingerprint image
13. To write a program to segment a document image
14. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/603	Skill/Practical-Based Activity-III	Credit:02	Contact Hours:60	Marks:50

Course Overview

The course has been designed to let the students acquire skills in his/her area of interest. As the aim of the course is to develop skills, the students can choose any one group of activities, which can be conducted under the guidance of a teacher. At the end, the student has to prepare a report on the skill acquired listing the practical work carried out throughout the semester.

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/603A	Skill based on Forensic Physics -III	02	60	50
		OR			
2	FOR/MJ/603B	Skill based on Digital Forensics-III	02	60	50
		OR			
3	FOR/MJ/603C	Skill based on Forensic Biology-III	02	60	50
		OR			
4	FOR/MJ/603D	Skill based on Forensic Chemistry-III	02	60	50
		OR			
5	FOR/MJ/603E	Skill based on Questioned Document, Fingerprint, and Biometrics-III	02	60	50

FOR/MJ/603A	Skill based on Forensic Physics-III	Credit:02	Contact Hours:60	Marks:50

List of activities

- Identification of various pattern evidence in forensic scenario
- Any other problem identified by the students

OR

FOR/MJ/603B	Skill based on Digital Forensics-III	Credit:02	Contact Hours:60	Marks:50

List of activities

- Retrieving data from the cloud
- Any other problem identified by the students

OR

FOR/MJ/603C	Skill based on Forensic Biology-III	Credit:02	Contact Hours:60	Marks:50

List of activities

- DNA Identification of various species
- Any other problem identified by the students

OR

FOR/MJ/603D	Skill based on Forensic Chemistry-III	Credit:02	Contact Hours:60	Marks:50

List of activities

- Analysis of Toxicological samples
- Any other problem identified by the students

OR

FOR/MJ/603E	Skill based on Questioned Documents, Fingerprints, and Biometrics-III	Credit:02	Contact Hours:60	Marks:50

List of activities

- Analysis of online fingerprints
- Analysis of iris biometric
- Any other problem identified by the students

Discipline Specific Elective Courses

FOR/DSE/604T	Pattern Evidences	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of pattern evidences including tool marks

Course Objectives

The course has the following objectives:

- Students will gain an idea of footwear marks and its importance in forensics
- Students will learn and apply principles of physics in tire and tire track examination
- Students will have an understanding of concepts of retreaded tires
- Students will learn the various aspects of tool marks examination

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to pattern evidences
- CO2: Apply principles of physics in pattern evidence examination
- CO3: Correlate the properties of source and pattern evidences
- CO4: Compare various characteristics of pattern evidences,
- CO5 Reconstruct pattern evidences from various sources

Unit	Course Content	Contact Hours
Unit-I	**Footwear marks** • Footwear sizing, manufacturing process of synthetic soled shoes, known shoes of suspects and the preparation of known impressions, wear characteristics, class and identifying characteristics, comparison of the questioned impression with known shoes, the footwear impression examiner in court, impression of the foot, some case applications	09
Unit-II	**Tire marks and tire track** • Introduction, sidewall information, tire construction, designs and databases, original equipment tires versus replacement tires, tire size designations, aspect ratio, noise treatment, tread wear indicators, known standards of tires, examination of tires, known	09

	standards of tires, examination of tire impressions, vehicle dimensions and turning, recovery methods specific to tires	
Unit-III	**Retreaded tires** • Retreaded tires tread design and dimension, tire wear, individual characteristics, examination methodology and procedure for comparison of tire impressions, presenting tire evidence in court, resources and databases, case studies	**09**
Unit-IV	**Plastic bag striations** • Introduction, background, plastic bag and film manufacture, Physical features, methods for visualization of physical features, chemical methods, protocol for forensic examination of plastic bags and films, value of plastic bag evidence	**09**
Unit-V	**Tool marks** • Importance, types of tool marks, nature, location, collection, methods of comparison, and results of comparison, evaluation and limitations of tool marks evidence. Relevant case studies.	**09**

Suggested Readings/Reference Books:

1. Encyclopedia of forensic sciences, volume 3, edited by Jay Siegel, G. Knupter, PekkaSaukko, Elsevier
2. Tire tread and tire track evidence recovery and forensic examination, William J. Bodziak, CRC series in practical aspects of criminal and forensic investigations, CRC press taylor and Francis group
3. Footwear impression evidence detection, recovery and examination, second edition, William J. Bodziak, CRC press
4. Forensic pattern recognition, 1st edition, Robert D. Keppel, Katherine M. Brown, Kristen M. Welch, ISBN-13: 978-0132329484
5. Forensic footwear evidence, William J. Bodziak, Practical aspects of criminal and forensic investigations series, CRC press
6. Criminalistics: an introduction to forensic science, textbook by Richard Saferstein, Pearson publication, twelfth edition
7. Tire Imprint Evidence, Peter McDonald, CRC Press

8. Tire Tread and Tire Track Evidence: Recovery and Forensic Examination,Author: William J. Bodziak, Apr-2008, CRC Press

9. Physical Evidence in Forensic Science Paperback – Import, 31 Jul 2006, by Henry C. Lee (Author), Howard A. Harris (Author), Publisher: Lawyers & Judges Pub Co; 2 edition (31 July 2006)
10. PLASTICS IN LIFE AND ENVIRONMENT, Dr. J.R. Bhat, http://envfor.nic.in/sites/default/files/press-releases/Lo_Book01.pdf

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FOR/DSE/604P	Practical based on FOR/DSE/604T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Pattern Evidences** (FOR/DSE/604T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Casting of 3D footwear/tire impressions using zip lock bag and bucket method
2. Casting of 3D footwear/tire impressions (Partially underwater and completely underwater).
3. Casting footwear impression in snow using snow print wax/sulphur/paraffins/auto paint primer spray and dental stone.
4. Photographic documentation of casted 3D and lifted 2D footwear impression.
5. Treatment and recovery of the 2D footwear/tire impression using adhesive lifting tape, gelatine lifting tape and carbon paper.
6. Treatment and recovery of the 2D footwear/tire impression using ESDA(vacuum box.
7. Treatment and recovery of the 2D footwear/tire impression (dental stone, microsil and liquid Silicone).
8. Enhancement of 2D footwear/tire impression by specialized lightning forensic photographic methods (using oblique light, cross polarization, UV light and IR light).
9. Enhancement of 2D wet muddy footwear footwear/tire impression by chemical methods (Potassium thiocyanate/ammonium thiocyanate method and 1,8-DIAZAFLUOREN-9-ONE (DFO)).
10. Recovering and enhancing 2D footwear/tire impressions on pieces of glass and plastic by using Safranin-O.
11. Recovering and enhancing 2D footwear/tire impressions containing $CaCO_3$ residue using Bromphenol Blue
12. Recovering and enhancing 2D footwear/tire impressions using chemical methods (8-hydroxyquinoline, cyanoacrylate fuming, Iodine).
13. Recovering and enhancing 2D footwear/tire impressions on raw metal surfaces that have a wet origin using antimony trichloride.
14. Enhancement of 2D footwear/tire impression by Physical developer method.
15. Chemical methods for enhancement of footwear impressions in blood (leuco crystal violet, Diaminobenzidine and amido black)
16. Chemical methods for enhancement of bloody footwear impressions using water soluble protein dyes (Patent Blue, Fuchsin Acid, Tartrazine, Ninhydrin, Luminol etc.)
17. Enhancement of 2D footwear/tire impression by using computer software and scanners.
18. Examination of comparison of tire marks impressions and their class and individual/accidental characteristics.
19. Examination of comparison of tire marks impressions on the basis of wear characteristics.
20. Physical examination of tires on the basis of sidewall information.
21. Chemical examination of tire residue from the skid marks for source identification.

22. Physical examination of plastic bags and films for source identification.
23. Examination of plastic packaging material by UV-Visible spectroscopic method.
24. Examination of plastic packaging material by FTIR spectroscopic method.
25. Examination of plastic packaging material by TLC method.
26. Microscopic examinations of plastic packaging materials for source identifications.
27. Examination of plastic bags on the basis of birefringence using cross polarization.
28. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/605T	Digital Image Processing	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of image processing and analysis

Course Objectives

The course has the following objectives:

- Students will gain an idea of image fundamentals
- Students will learn and apply image enhancement techniques
- Students will have an understanding of concepts of segmentation and compression
- Students will learn the concept of image description and multiresolution processing

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to image processing and analysis
- CO2: Apply image enhancement techniques
- CO3: Analyze various images using compression
- CO4: Compare various edge detection techniques
- CO5: Implement morphological image processing techniques

Unit	Course Content	Contact Hours
Unit-I	**Image Fundamentals** • Image Fundamentals: definition and types of images, co-ordinate convention, Human visual system and computer vision system, digitization and Shannon sampling theorem, zooming and shrinking of an image, relationship between pixels: neighbours, adjacency, connectivity and path. Distance measures between pixels.	09
Unit-II	**Image Enhancement** • Introduction and scope of image enhancement. • Image enhancement in spatial domain: point processing-basic point operators, histogram normalization and histogram equalization, thresholding. Mask processing-mean filter, median filter, Gaussian and Laplacian filter.	09

	• Image enhancement in the frequency domain, concepts of Fourier transform and enhancement in the frequency domain, power spectrum and phase angle, Low pass, high pass, and band pass filters, homomorphic filtering	
Unit-III	**Mathematical morphology and segmentation** • Mathematical morphology: basic morphological concepts, binary dilation and erosion, opening and closing, hit-or-miss transformation, Gray-scale dilation and erosion, opening and closing, top hat and geodesic transformation. • Fundamentals of image segmentation, edge detection, thresholding, region-based segmentation	**09**
Unit-IV	**Image compression** • Compression: basic concepts of image compression, redundancy, and fidelity criteria, image compression models, lossy compression: vector quantization, loss less compression: run length coding, Huffman transformation, JPEG compression	**09**
Unit-V	**Multiresolution processing, image description and representation** • Wavelet: Basic concepts of wavelet and multiresolution processing • Feature Extraction: Basic concepts of feature extraction and description of images.	**09**

Suggested Readings/Reference Books:

1. Digital Image Processing by Gonzalez and Woods.
2. Digital Image Processing and Analysis by Chanda and Majumdar
3. Feature Extraction and Analysis by Mark Nixon
4. Digital Image Processing by Ionis Pitas
5. Digital Image Processing by Anil K Jain

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FOR/DSE/605P	Practical based on FOR/DSE/605T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Digital Image Processing** (FOR/DSE/605T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Write a code in Python for reading and writing of a digital image
2. Write a code in Python for contrast stretching and histogram equalization
3. Write a code in Python for enhancement of image using mean filters
4. Write a code in Python for the enhancement of the image using median filters
5. Write a code in Python for enhancement of image using low pass and high pass filters
6. Write a code in Python for edge detection using Sobel operators
7. Write a code in Python for edge detection using Prewitt operators
8. Write a code in Python for edge detection using Robert's operators
9. Write a code in Python for edge detection using Laplacian of Gaussian operators
10. Write a code in Python for edge detection using the Canny operator
11. Write a code in Python for implementing Gray-scale morphological operators
12. Write a code in Python for implementing binary morphological operators.
13. Write a code in Python for the compression of an image
14. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/606T	Immunology and Advanced Immunotechniques	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of immunology and immunotechniques

Course Objectives

The course has the following objectives:

- Students will gain an idea of immunology and immunotechniques
- Students will learn and apply immunological techniques
- Students will have an understanding of concepts of antigen-antibody reactions
- Students will learn the concept of transplantation science

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to immunology and immunotechniques
- CO2: Apply principles of immunology
- CO3: Analyze various concepts of antigen-antibody reactions
- CO4: Compare various characteristics of autoimmune disorders
- CO5: Implement immunological techniques

Unit	Course Content	Contact Hours
Unit-I	**Immunity & Organs of the Immune System** • Immunity: Innate, Acquired, Humoral, Cell mediated, Immunization (Active & Passive) • Antigen, Epitopes, Immunogenicity, Antigenicity of a compound, Factors influencing antigenicity, Haptens, Adjuvants, Chemical basis of antigen specificity, Superantigens. • Antibody: Basic structure, Fine structure, Classes & their biological activity, • Cells & Organs of Immune System: Primary & Secondary Lymphoid Organs, Lymphatic System, Haematopoiesis	09
Unit-II	**Cell receptor, MHC and diversity** • BCR, TCR: Structure & organization, • MHC: Structure & Organization of Class I & Class II MHC, Polymorphism of MHC, Self MHC	09

	Restriction, Alloreactivity of T-cells, MHC restriction. • Multigene Organization, Recombination, Generation of antibody diversity, Class Switching, Ig-Superfamily, Complement system	
Unit-III	**Antigen-Antibody interactions & Hybridoma technology** • Antigen-antibody interactions; • Gel immuno-diffusion, Radio Immunoassay, Enzyme-Linked Immuno-Sorbent Assay and fluorescence immunoassay, Immuno-assays: Single Radial Immune, Diffusion, Immunodiagnostics and immunotherapy. • Hybridoma technology and monoclonal antibodies	**09**
Unit-IV	**Transplantation science** • Transplantation, graft vs host reaction, mixed lymphocyte reaction; Cytokines, Types of graft, Acceptance & Rejection of Graft, Stem cell banks and their importance.	**09**
Unit-V	**Autoimmune disorders and Hypersensitivity** • Autoimmune disorders; Hypersensitivity • Vaccines: natural, synthetic & genetic, Problem and prospect associated with the development of vaccine for diseases like AIDS, Cancer and Malaria. Immunodiagnostics and immunotherapy in virology	**09**

Suggested Readings/Reference Books:

1. Immunology: An Introduction by I.R. Tizard.
2. Kuby Immunology: Kindt, Goldsey, Osborne.
3. Immunology: Roitt, Brostoff, male.
4. The elements of Immunology: FahimHalim Khan
5. Fundamental immunology William E. Paul
6. Microbial Forensics: Roger G Breeze, Bruce Budowle, Steven E Schutzer
7. Handbook of computational molecular biology: Edt by SrinivasAluru
8. S.C. Rastogi, N. Mendiratta & P. Rastogi: Bio-informatics- Methods & Applications, PHI learning pvt. Ltd., (2009)

9. Dr. Westhead, J.H. Parish & R.M. Twyman, Bio-informatics, Viva Books Pvt Ltd., (2003)
10. Introduction to bioinformatics: Lesk
11. Blood biochemistry: Nicholas J Russell
12. Human blood groups-Chemical and biochemical basis of antigen specificity (Second edition): Helmut Schenkel –Brunner, Springer Wein New York
13. Blood: Principles and practice of hematology (2003): Robert L Handin, Samuel Lux, Thomas Stossel
14. Medical laboratory techniques: Godkar and Godkar
15. Blood group typing: Danford and bowly.
16. Blood grouping on man: R.R. Race and Sanger.
17. Blood grouping techniques: Boorman, Dodd. B, Lincoln. PB
18. Typing of blood stains: Callifird. Bryan

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FOR/DSE/606P	Practical based on FOR/DSE/606T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Immunology and Advanced Immunotechniques** (FOR/DSE/606T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Blood examination for diseases
2. Estimation of haemoglobin percentage
3. Microscopic study of abnormal RBCs
4. To determine blood group from stains of blood and various body fluids with Absorption inhibition, mixed agglutination, and absorption-elution techniques.
5. Determination of secretor and non-secretor status
6. To perform a precipitin test for species of origin determination.
7. Rocket immunoelectrophoretic
8. Microscopic study of sperm and its abnormality using a compound microscope
9. Sperm counting by haemocytometer
10. Western blotting analysis
11. Detection of semen
12. WIDAL Test
13. VDRL
14. Spot Elisa
15. Ouchterlony Double diffusion
16. Cross Over Electrophoresis
17. Examination of bloodstains: physical and chemical tests; spectroscopic examination.
18. Examination of seminal stains: crystal tests, chemical, biochemical, Microscopical and electro-immuno-diffusion test.
19. Examination of saliva and its stains: microscopical and chemical tests.
20. Faecal stains: Physical, chemical and microscopical examination, testing of urine and sweat
21. Visit autopsy centre at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Centre, Biodiversity and wildlife Centre.
22. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/607T	Analytical Chemistry	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of analytical chemistry

Course Objectives

The course has the following objectives:

- Students will gain an idea of basic separation techniques
- Students will learn and apply principles of chromatography
- Students will have an understanding of various chromatographic systems
- Students will learn the instrumentations of chromatographic techniques

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to chromatography
- CO2: Apply principles of chromatography in forensic problems
- CO3: Analyze various compounds using chromatographic techniques
- CO4: Compare various characteristics of molecules using chromatography
- CO5: Analyze compounds using GC and HPLC specifically

Unit	Course Content	Contact Hours
Unit-I	**Basic Separation Techniques** • Distillation: fractional distillation, distillation under vacuum, theory of operation of distillation methods and practical considerations • Solvent and solid phase extraction: phase equilibrium, the partition coefficient, the distribution ratio, theory of phase contact methods, single equilibrations, repeated equilibrations, counter current distribution, practical aspects and applications-extraction of metals, extraction of molecular species, ion pair extractions, accelerated and microwave-assisted extractions, solid phase extraction	09
Unit-II	**Chromatography**	09

	• Introduction, basic principles, and theory of chromatographic techniques, plate theory of chromatography, rate theory of chromatography, other factors in zone broadening • Development of chromatogram: frontal analysis, elution analysis, displacement analysis, selection of chromatography system, qualitative and quantitative analysis of chromatography	
Unit-III	**Chromatographic system-I** • Thin layer chromatography: basic principles, experimental techniques, solvent systems, plate development, detection of components, evaluation of chromatogram by different methods, applications of TLC • Liquid-liquid partition chromatography: introduction, theory, solid supports, selection of stationary and mobile phases, reverse phase chromatography, choice of adsorption or partition, application of partition chromatography	**09**
Unit-IV	**Chromatographic system-II** • Column chromatography: principle, experimental details, theory of development, column efficiency, factor affecting column efficiency and applications • Gel permeation chromatography: principle, materials, gel preparation, column packing, detectors and applications • Ion exchange chromatography: ion-exchange resins, ion exchange equilibria, ion exchange capacity of resins and its determination, applications of ion exchange resins in chromatography, ion chromatography based on suppressors	**09**

Unit-V	**Instrumental methods** • Gas chromatography: introduction, principle of gas-liquid chromatography, instrumentation-carrier gas, sample introduction system, columns, detectors, substrates, temperature control, retention volume, resolution, pyrolysis Gas chromatography, GC-MS and applications • High-performance liquid chromatography: principle, instrumentation-column, column packing, mobile phase, pumping system, detector, practical procedure, applications, HPLC adsorption, and partition chromatography	**09**

Suggested Readings/Reference Books:

1. Fundamental of Analytical Chemistry, Skoog, Hollar and Couch, 8th Edition
2. Analytical Chemistry, G. D. Christian, 6th Edition
3. Chemical separation and measurements, Peters, Hayes and Hieftie
4. Instrumental methods of analysis, Skoog

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FOR/DSE/607P	**Practical based on FOR/DSE/607T**	**Credit:01**	**Contact Hours:30**	**Marks:50**

Course Overview

This is a laboratory course based on **Analytical Chemistry** (FOR/DSE/607T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Perform fractional distillation of two volatile liquids **(minimum two)**
2. Perform separation of metals **(minimum two)**
3. Perform separation of molecular species **(minimum two)**
4. Perform separation of ion pairs **(minimum two)**
5. Perform separation and quantification of a chemical using TLC **(minimum three)**
6. Perform separation and quantification a chemical using HPLC **(minimum three)**
7. Perform separation and quantification a chemical using GC **(minimum two)**
8. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/608T	Microscopy and Photography	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of microscopy and photography

Course Objectives

The course has the following objectives:

- Students will gain an idea of basic optics
- Students will learn and apply microscopic techniques
- Students will have an understanding of conventional photography
- Students will learn the concept of digital photography

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to microscopy and photography
- CO2: Apply image microscopic techniques
- CO3: Analyze various photographic conditions
- CO4: Compare properties of various image formats
- CO5: Implement photographic techniques

Unit	Course Content	Contact Hours
Unit-I	**Fundamentals of Optics** • Light and its properties, Refraction and refraction from different surfaces, Fundamental of Light and vision, Aberration, Colour theory. • Application of optics: Contact lens, Eyeglass, Magnifying lens, Microscopes, Camera, CD's and DVD's.	09
Unit-II	**Optical Microscopy** • Basic Principle, Instrumentation, Working and Applications of: Polarizing Microscope, Reflected Light Microscope, Phase contrast Microscope, Fluorescence Microscope, Polarized microscope, Fluorescence microscope, Phase contrast, Differential interference contrast microscope, TIR fluorescence microscope, Laser microscope, structured illumination microscope	09
Unit-III	**Electron Microscopy**	09

	• Basic principle, Instrumentation, Working and Applications of: Scanning Electron microscope, Cryo-SEM, Scanning Probe Microscope, Scanning Tunneling Microscope, Transmission electron microscope, Scanning transmission electron microscope, Electron tomography, Electron backscatter diffraction, Reflection electron microscope	
Unit-IV	**Fundamentals of Photography** • Definition and basic principles, history and development of photography, Camera and its essential parts, Types of camera essentials. • Camera Controls: Effect of aperture, Shutter speed and ISO on photograph. • Film Photography: Types of film, Development of film and photograph, Linkage of camera and negatives.	**09**
Unit-V	**Digital Photography and applications** • Digital Photography: Types of sensors, Color theory, image formats. • Forensic Application: Photogrammetry, Filter photography, specialized photography, Photography on challenging surfaces.	**09**

Suggested Readings/Reference Books:

1. Concept of Quantum Optics, P L Knight, L Allen, Pregamon Press.
2. Basic Optics: Principle and Concepts, Avijit Lahiri, Elsevier 2006.
3. Optics and optical instruments, B K Johnson, Dover Publication inc.
4. Optics and optical instruments, Dionysius Lardner, LULU Press 2010.
5. The Microscope Book, Shar Levine, Sterling Publishing Company.
6. An Introduction to the theory and use of microscope, C R Mashall, Read Books 2007.
7. Light and Electron Microscopy, Elizabeth M Slayter, Henry S Slayter, Cambridge University Press.
8. Scanning Tunelling Microscope and its applications(Second revised edition), C Bai, Springer.
9. Scanning electron Microscope(Second edition), L Reimer, Springer.

10. Practical Electron Microscopy, Elaine Hunter, Cambridge university press.
11. The principle and practice of electron microscopy(Second edition), Ian M Watt, Cambridge university press.
12. Optical imaging and Microscopy, Peter Torok and Fu Jen Kao, Springer.
13. Fundamental of Light Microscopy, Michael Spencer, Cambridge University Press.
14. Physical Principles of Electron Microscopy, Ray F Egerton, Springer.
15. Analytical and quantitative methods in microscopy, G A Meek, H Y Elder, Cambridge University press.
16. Photography, John Freeman, Collins and Brown.
17. A concise history of photography, Helmut Gernsheim, Dove publications.
18. Optics in Photography, Rodolf Kingslake, Spie optical engineering press.
19. Digital Photography, Ken Milburn, OReillly press.
20. Basic Photography, Michael Langford, Focal Press.
21. Magic: Stage illusions, special effects and trick photography, Albert A Hopkins, Diver
22. Color Theory, Patti Mollica, Walter Foster Publishing

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FOR/DSE/608P	Practical based on FOR/DSE/608T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Microscopy and Photography** (FOR/DSE/608T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To study the different camera controls.
2. Document photographic techniques – Close up photography, UV , IR, Transmitted and oblique light photography (**at least one for each**)
3. Contact and trick photography.
4. Photography of Watermarks and wire marks.
5. Analysis of samples using optical microscope (**minimum two**)
6. Analysis of samples using Comparison microscope (**minimum two**)
7. Analysis of samples using Stereo microscope (**minimum two**)
8. Analysis of samples using Phase contrast microscope
9. Photography of secret writings.
10. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/609T	Forensic Psychology and Criminology	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of forensic psychology and criminology

Course Objectives

The course has the following objectives:

- Students will gain an idea of forensic psychology and criminal behavior
- Students will learn and apply psychological techniques
- Students will have an understanding of sexual offenders and juvenile delinquency
- Students will learn various schools of criminology

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to forensic psychology and criminology
- CO2: Apply various psychological techniques
- CO3: Analyze various aspects of criminal behavior
- CO4: Compare various behavioral aspects
- CO5: Analyze propositions of various school of criminology

Unit	Course Content	Contact Hours
Unit-I	**Forensic Psychology and Criminal behavior** • Review of Forensic Psychology: Introduction, definition, History, development. • Ethics of Forensic Psychology • Psychopathology and Abnormal behaviour-Definition, nature • Models of abnormal behaviour • Biological factors & Crime, Social Learning theories, Psychosocial Factors, Abuse. • Intelligence & Crime, Effects of Media, Gender & Crime • Psychology of Terrorism.	09
Unit-II	**Juvenile Delinquency** • Theories of Offending: Social Cognition, Moral Reasoning. • Child Abuse: Physical, Emotional, Sexual • Juvenile Sex Offenders	09

	• Prevention of Delinquency
	• Areas under Forensic Psychology
	  ○ Competency to stand trial
	  ○ Sentence Litigation
	  ○ Criminal Responsibility
	  ○ Civil Commitment
	  ○ Guardianship and Conservatorship	

Unit-III	**Sexual offenders** • Sexual offenders- Nature, definition of Sexual assault • Consequences of sexual assault • Classification of sexual offenders- Rapist typologies, Child Molester typologies • Adolescent sexual offender • Assessment and treatment of sexual offender- Denial, empathy, social skills, substance abuse, deviant sexual interest, relapse prevention	**09**
Unit-IV	**Introduction to Criminology** • Criminology: Meaning, Definition, Nature, and Scope • Criminology and other Social Sciences • Criminology vs. Criminal Justice. • Role of Legislature and Law-making; Participation of Victims and Witnesses in the Criminal Justice Process, • Crime Prevention: Neighborhood Involvement.	**09**
Unit-V	**School of criminology** • Schools of Criminology: Demonology, Classical, Neo-Classical Schools, Positivist / Positive School, Cartographic School, Biological and Constitutional School- Body Types, Hereditary Traits, Endocrine Glands; Economic Theories of Crime; Multiple Factors.	**09**

	• Crime and Social Process: Socialization and Crime-Differential association theory, Differential reinforcement theory.	

Suggested Readings/Reference Books:

1. Criminology by Larry Siegel
2. Introduction to Forensic Psychology by Bruce Arrigo
3. Forensic & Criminal Psychology by Dennis Howitt.
4. Abnormal Psychology by Halgin and Whitbourne.
5. Abnormal Psychology by Robert C. Carson, James N. Butcher, Susan Mineka, Jill M. Hooley thirteenth Edition, Thirteenth Edition.
6. Encyclopedia of Forensic Science by Jay A. Siegel, PekkaJ. Saukko, Geoffey C. Knupfer. Volume-1 to Volume-5.
7. Teisi Thou (2011) Forensic Psychology, New Delhi: ABD Publisher
8. Peter Joyce and Wandy Laverick, Criminology: A Complete Introduction, 2020
9. Ram Ahuja, Criminology, Rawat Publications, 2000

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FOR/DSE/609P	Practical based on FOR/DSE/609T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Psychology and Criminology** (FOR/DSE/609T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. NEO-PI
2. Self-Expression Inventory.
3. Social Intelligence Test
4. Religiosity Scale Test
5. Bhatia's Battery for Intelligence
6. BEOSP: Formulating the Probes.
7. Thematic Apperception Test
8. WAIS/WAPIS
9. Roggers Criminal Responsibility Assessment Scale
10. Sexual Violence Risk -20
11. Any other practical designed by the faculty member based on recent advances/latest trends

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Research Project

FOR/RP/649	Research Project-I	Credit:04	Contact Hours:120	Marks:100

Course Overview

The students based on their interests can select a research project in the following domains. At the end of the semester, students have to submit a complete research project based on their findings.

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/RP/649A	Research project in Forensic Physics -I	04	120	100
		OR			
2	FOR/RP/649B	Research project in Digital Forensics-I	04	120	100
		OR			
3	FOR/RP/649C	Research project in Forensic Biology-I	04	120	100
		OR			
4	FOR/RP/649D	Research project in Forensic Chemistry-I	04	120	100
		OR			
5	FOR/RP/649E	Research project in Questioned Document, Fingerprint, and Biometrics-I	04	120	100

FOR/RP/649A	Research project in Forensic Physics -I	Credit:04	Contact Hours:120	Marks:100

Course Overview

This student needs to select a research topic in Forensic Physics. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/649B	Research project in Digital Forensics-I	Credit:04	Contact Hours:120	Marks:100

Course Overview

This student needs to select a research topic in Digital Forensics. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be

approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/649C	Research project in Forensic Biology-I	Credit:04	Contact Hours:120	Marks:100

Course Overview

This student needs to select a research topic in Forensic Biology. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/649D	Research project in Forensic Chemistry-I	Credit:04	Contact Hours:120	Marks:100

Course Overview

This student needs to select a research topic in Forensic Chemistry. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/649D	Research project in Questioned Document, Fingerprint, and Biometrics -I	Credit:04	Contact Hours:120	Marks:100

Course Overview

This student needs to select a research topic in Forensic Questioned Document, Fingerprint, and Biometrics. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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Semester-IV

Detailed Curriculum of Semester-IV

Discipline-Specific Core Courses

FOR/MJ/650T	Special Paper-IV	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course has been designed to get the students specialized in a particular domain of forensic science. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/650AT	Instrumentation in Forensic Physics	03	45	75
		OR			
2	FOR/MJ/650BT	Mobile Phone Forensics	03	45	75
		OR			
3	FOR/MJ/650CT	DNA Forensics	03	45	75
		OR			
4	FOR/MJ/650DT	Forensic Chemistry of Food and Industrial Products	03	45	75
		OR			
5	FOR/MJ/650ET	Advanced Document Examination	03	45	75

FOR/MJ/650AT	Instrumentation in Forensic Physics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of spectroscopic techniques and advances in sensor technologies.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the fundamentals of spectroscopy
- Students will learn and analyze materials using spectroscopic techniques
- Students will have an understanding of X-ray spectroscopy
- Students will understand the concepts of sensors
- Students will learn the advances in sensor technologies

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to spectroscopy
- CO2: Apply spectroscopic techniques for analysis of samples

- CO3: Analyze evidence using X-ray spectroscopic techniques
- CO4: Compare properties of various sensors
- CO5: Analyze the characteristics of a sensor

Unit	Course Content	Contact Hours
Unit-I	**Introduction to spectroscopy** • Introduction to spectroscopy, Interaction of electromagnetic radiations with matter: phenomena of absorption, emission, reflection, fluorescence, phosphorescence. Basic concepts of atomic spectra, energy levels, quantum numbers, designation of states, selection rules, atomic spectra.	09
Unit-II	**Spectroscopic techniques** • Raman Spectroscopy; Atomic Absorption Spectroscopy, Atomic Emission Spectroscopy, Fluorescence and phosphorescence spectroscopy, Infrared spectrophotometry, Ultra violet and visible spectroscopy	09
Unit-III	**Elements of X-ray spectrometry** • X-ray absorption and fluorescence, Energy Dispersive X-ray Analysis (EDX), wavelength Dispersive X-ray analysis (WDX), X-ray diffraction, Auger emission spectroscopy and applications. Radio Techniques: Basic principles and theory introduction about nuclear reactions and radiations, Neutron sources, Neutron Activation Analysis.	09
Unit-IV	**Sensors** • What are sensors, principles, classification, sensor parameters, environmental parameters, characterizations: electrical, mechanical, optical and chemical characterizations. Electromechanical, Thermal, Magnetic and Radiation sensors.	09
Unit-V	**Recent trends in sensor technology** • Introduction, Film sensors: Thick film sensors, Thin film sensors, Semiconductor IC technology, Microelectrochemical systems: Micromachining, Nano-sensors and applications of sensors.	09

Suggested Readings/Reference Books:

1. Fundamentals of molecular spectroscopy by C. N. Banwell
2. N B Colthup, L H Daly, S E Wiberley, Introduction to infrared and Raman spectroscopy, Auflage(1975), Academic Press, New York.
3. JM Hollas: Modern Spectroscopy, John Wiley, 1992

4. A basic course in Crystallography JAK Tareen and TRN Kutty, University Press
5. Nuclear Physics Harry Henderson University Press
6. Sensors and Transducers by D. Patranabis 2nd Edition, PHI Learning Private Limited.
7. Practical Sampling Techniques for Infrared Analysis by Patricia B. Coleman
8. Organic spectroscopy PS Kalsi
9. Physical Optics; A.K.Ghatak
10. Fundamental of Optics; F.A.Jenkins, H.E.White
11. Principles of Optics; D.S. Mathur
12. Introduction Spectroscopy by Pavia
13. Spectroscopic identification of organic molecules by Silverstein
14. Atomic Physics; J. B. Rajam
15. Introduction to atomic spectra H E White
16. Nuclear Physics D. C Tayal

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FOR/MJ/650BT	Mobile Phone Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of mobile and smart phone forensics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of mobile forensics
- Students will learn and analyze various mobile phones
- Students will have an understanding of android forensics
- Students will understand the concepts of window forensics
- Students will learn the concepts of iOS forensics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to mobile forensics
- CO2: Apply various techniques to analyze mobile phones
- CO3: Analyze various non-android phones
- CO4: Compare properties of android and non-android phones
- CO5: Analyze the concepts of iOS forensics

Unit	Course Content	Contact Hours
Unit-I	**Introduction to mobile forensics** • Mobile Devices as Digital Evidence Sources • The Mobile Forensics Process (Acquisition, Analysis, Reporting) • Mobile Device Landscape (Android, iOS, Other Platforms)	09
Unit-II	**Mobile device fundamentals** • Operating System Overview (Android, iOS) • Mobile Device Storage and File Systems • Understanding Mobile Applications and Data Storage	09
Unit-III	**Mobile data acquisition** • Logical vs. Physical Acquisition Techniques • Mobile Forensics Tools for Acquisition (Software and Hardware) • Best Practices for Evidence Acquisition and Chain of Custody	09
Unit-IV	**Mobile data analysis** • Extracting Call Logs, SMS, Contacts, and Multimedia Files	09

	• Analyzing Application Data and User Activity • Recovering Deleted Data and Hidden Artifacts	
Unit-V	**Mobile forensics tools** • Popular Mobile Forensics Tools (e.g., Cellebrite, Oxygen Forensics) • Utilizing Tools for Data Extraction, Analysis, and Reporting • Advanced Features and Functionality of Mobile Forensics Software	**09**

Suggested Readings/Reference Books:

1. Practical Mobile Forensics, Satish Bommisetty, Rohit Tamma, Heather Mahalik, Packt Publishing Ltd., 2014,ISBN 978-1-78328-831-1
2. Learning iOS Forensics, Mattia Epifani, Pasquale Stirparo,Packt Publishing Ltd, 2015,ISBN 978-1-78355-351-8 iPhone and iOS Forensics Investigation, Analysis and Mobile Security for Apple
3. iPhone, iPad, and iOS Devices by Andrew Hoog, Katie Strzempka ,Publisher Synergy Mobile phone security and forensics: A practical approach by Iosif I. Androulidakis,Springer publications, 2012

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FOR/MJ/650CT	DNA Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of DNA and its applications in forensics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of sample collection in the case of DNA
- Students will learn and analyze DNA
- Students will have an understanding of DNA extraction and quantifications
- Students will understand the concepts of STR profiling
- Students will learn the concepts of non-human DNA

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to DNA Forensics
- CO2: Apply various techniques to analyze DNA
- CO3: Analyze various non-human DNA
- CO4: Compare properties of human and non-human DNA
- CO5: Analyze the limitations of DNA profiling

Unit	Course Content	Contact Hours
Unit-I	**Sample collection and chain of custody** • DNA sample sources, biological evidence at crime scenes, evidence collection and preservation, collection of reference DNA samples, storage and sample characterization, sample storage and transport of DNA evidence, sample characterization: blood stain, saliva stains, semen stains, body fluid identification by RNA testing, contamination concerns	09
Unit-II	**DNA extraction and quantification methods** • Organic (Phenol-chloroform) extraction, Chelex extraction, FTA paper, Solid phase DNA extraction methods: Qiagen extraction Chemistry and kits, DNA IQ (Identification & quantification), Pre-Filer, Differential extraction, Direct PCR. • DNA quantification: Slot blot, Pico-green micro-titre plate assay, Alu-Quant human DNA quantification system, endpoint PCR, real time quantitative PCR (qPCR).	09
Unit-III	**STR Typing**	09

	• Introduction to Forensic Genetics and DNA testing, Genetic markers and their forensic significance, Types of STR markers, STRs used in forensic DNA typing, core and common STR markers. • Structure of STR loci, Development of STR multiplexes, Detection of STR polymorphisms, Interpretation of STR profiles, Assessment of STR profiles, Stutter peaks, split peaks, pull up, template DNA, overloaded profiles, low template DNA typing, peak balance, mixtures, degraded DNA, PCR inhibition.	
Unit-IV	**Non-human DNA** • Non-human DNA testing: Sources, domestic animal DNA testing (cat DNA, dog DNA), Canine STR Loci and assays, Canine Mt-DNA Testing, species identification: (Mt-DNA Cytochrome-b gene, Mt-DNA 12S rRNA gene, Mt-DNA COI gene).	**09**
Unit-V	**DNA Profiling and its applications** • DNA profiling applications & case studies in disputed paternity cases, child swapping, missing person's identity, civil immigration, veterinary, wild life and agriculture cases; • Legal perspectives – legal standards for admissibility of DNA profiling – procedural & ethical concerns, status of development of DNA profiling in India & abroad; • Limitations of DNA profiling; Population databases of DNA markers –STRs, Mini STRs, SNPs, DNA Bill.	**09**

Suggested Readings/Reference Books:

1. An Introduction to Forensic DNA Analysis, Rudin, Norah CRC Leviw Publishers, (2002)
2. An Introduction to Forensic DNA Analysis, Inman, Keith CRC Press, (1997)
3. Ancient DNA, Herrmann, Bernd Springer Publishing Co., (1994)
4. Basics of DNA and Evidentiary Issues, Vij, Krishan Jaypee Brothers, (2004)
5. DNA, forensic and legal applications Kobilnsky, Lawrence John Wiley & Sons, (2005)
6. DNA Cloning 4: Mammalian systems, Glover, D.M.; IRL Press,(1995)
7. DNA Damage and repair, Nickoloff, Jac A Humana Press,(1998)
8. DNA Evidence and Forensic Science, Newton, David E. Viva books private limited, (2010)
9. DNA fingerprinting, Kirby, Lorne W H Freeman and Co, (1992)
10. DNA Fingerprinting: Approaches and applications. T. Burke, Terry Birkhauser Verlage,(1991)

11. DNA in forensic science, Robertson, J Ellis Horwood Ltd., (1990)
12. DNA profiling Easteal, Simon, Harwood academic Publishers,(1993)
13. DNA profiling and DNA fingerprinting, Epplen, Jorg T Birkhauser Verlage,(1999)
14. DNA technology. Alcamo, I Edward Harcourt Academic Press,(1999)
15. DNA tests in Criminal Investigation Trial & Paternity Disputes Singh, Yashpal, Alia Law Agency (2006)
16. Forensic DNA typing. J.M. Butler Elsevier Academic press,(2005)
17. Forensic DNA technology, Mark A. Farley & James J. Harrington CRC Press,(1991)
18. Forensic DNA analysis, J. Thomas McClintock Lewis Publications, (2008)
19. Forensic DNA typing protocol: Carracedo

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FOR/MJ/650DT	Forensic Chemistry of Food and Industrial Products	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of forensic chemical analysis of food and industrial products.

Course Objectives

The course has the following objectives:

- Students will gain an idea of the food chemistry
- Students will learn and analyze alcohol and alcoholic beverages
- Students will have an understanding of dyes, paint, and pigments
- Students will understand the concepts of fibers and fertilizers
- Students will learn the concepts of cement, concrete and mortar

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to food chemistry
- CO2: Apply various techniques to analyze alcohol and alcoholic beverages
- CO3: Analyze various fibers and fertilizers
- CO4: Compare properties of dyes, paint and pigments
- CO5: Analyze the characteristics of cement, mortar and concrete

Unit	Course Content	Contact Hours
Unit-I	**Food Chemistry** • Analysis of lipids, fats and oils: Physical and Chemical examination of lipids, Acid value, Saponification value, Ester value, Acetyl value, Iodine value, Test for hydrogenated oils and fats, Detection and Determination of rancidity, Analysis of butter and butter fats, Analysis of adulterated and non-adulterated oils • Analysis of dairy products: Physical examination, nutrition value, chemical examination, and adulteration of milk and its products	09
Unit-II	**Alcohols and alcoholic beverages** • Alcohols and alcoholic beverages, Analysis of alcohols, country made liquor, illicit liquor and medicinal preparations, Analysis of various denaturants of alcohol, detection and determination of ethanol, methanol, aldehyde, ester by color test and instrumental technique.	09
Unit-III	**Dyes, paint and pigments**	09

	• Dyes: Different types of dyes, role of dyes in crime investigation, food colors (edible and non-edible dyes); dyes used in cosmetic and pharmaceutical products. Chemical and instrumental methods of analysis of dyes. Forensic Significance. Related Case studies. • Paint: Types of paint and their composition, physical examination of paint, instrumental analysis of pigment, interpretation of paint evidence, Chemical and physical properties of paint. Analysis of paint, Raman and IR spectroscopic analysis of Paints. Forensic Significance, Related Case studies • Pigments: Introductions, properties of blue pigment, white pigments, red pigment, green pigment, yellow pigment, Forensic Significance.	
Unit-IV	**Fibers and fertilizers** • Fibers: Introduction to fibers, Classification of fibers, Analysis by microscopy, melting point and solubility testing of fibers, Analysis of fiber FT-IR, forensic chemical analysis. Analysis of fibers by thermal methods such as DSC, TGA. • Fertilizers: Introduction, Types of fertilizers and classification, Adulterated fertilizers, common adulterants in fertilizer; Estimation of the nitrogen, phosphorous and potassium content in fertilizer, Chemical and physical methods analysis of fertilizers; forensic analysis of organic and inorganic fertilizers	**09**
Unit-V	**Cement, mortar and concrete** • Chemical compositions Portland cement and other type of cements; Methods of sampling of cements, mortar and concrete; Common adulterants of cement and their detection. o Methods of analysis o Physical analysis-microscopic examination, Ignition tests, Sieve test, Density Gradient test. o Chemical analysis of cement, mortar and concrete. Instrumental analysis of cement by TGA, DTA, AAS, etc; Case Studies like Structural Failures, etc.	**09**

Suggested Readings/Reference Books:

1. Pearson D; "Chemical Analysis of Food", Chemical Publ. Co. New York, 1971.
2. JaVed I. Khan, Thomas J. Kennedy, Donnell R. Christian Jr.; Basic Principles of Forensic Chemistry; Springer Science, Humana Press, ISBN 978-1-59745-437-7; 2012

3. Jay Siegel, Geoffrey Knupfer, Pekka Saukko; Encyclopedia of Forensic Sciences, Three Volume Set; Elsevier Publications; ISBN 0122272153
4. Manuals of Food Quality Control, Food analysis: quality, adulteration and tests of identity; FAO of United Nations, ISSN 0254-4725, 1996
5. Jay A. Siegel, Forensic Chemistry : Fundamentals and Applications; John Wiley & Sons, Ltd, ISBN 978-1-118-89772-0, 2016
6. Bogen, E. (1932). The human toxicology of alcohol. In H. Emerson (Ed.), Alcohol and Man (pp. 126–152). New York, NY: The Macmillan Company
7. Emerson, V. (2004). Alcohol analysis. In P. C. White (Ed.), Crime scene to court - The essentials of forensic science (2nd ed., pp. 350–376). Cambridge, England: Royal Society of Chemistry.

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FOR/MJ/650ET	Advanced Document Examination	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of document examination including forensic accounting, numismatic forgery, examination of security documents, forensic linguistics and stylistics

Course Objectives

The course has the following objectives:

- Students will gain an idea of forensic accounting and auditing
- Students will learn and analyze security documents
- Students will have an understanding of forensic linguistics and stylistics
- Students will understand the concepts of numismatic forgery
- Students will learn the concepts of quality assurance and expert testimony

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to accounting and auditing
- CO2: Apply forensic linguistics and stylistics to analyze a document
- CO3: Analyze various security documents
- CO4: Compare provisions of expert testimony
- CO5: Analyze various numismatic forgery

Unit	Course Content	Contact Hours
Unit-I	**Forensic Accounting and Auditing** • Basic concept on account: accounting process, recording of transactions, financial statements, etc., Fraud, a brief history of fraud, types of fraud: employee fraud and financial statement fraud, Forensic accounting, application of forensic accounting, fraud detection, the role of forensic accountant, sources of information, bank and financial institutions fraud, insurance fraud, cheque and credit card fraud, payroll fraud and their investigation etc., introduction to forensic auditing, types of Auditing	09
Unit-II	**Forensic Linguistics and Stylistics** • History and Definition of Forensic linguistics, disciplines of forensic linguistics: Auditory phonetics, acoustic phonetics, semantics, Discourse and pragmatics, dialect and idiolect, plagiarism detection, psycholinguistics. Language, variation in language,	09

	• Stylistics: Introduction, style in language, linguistic stylistic, qualitative and quantitative analysis of style, style markers- text format, number and symbol, abbreviation, punctuation, capitalization, spelling, word formation, syntax, error and correction, high frequency word and phrases.	
Unit-III	**Numismatic forgery** • Numismatic forgery- Introduction, tool, equipment and other resource, method of forgery: alteration, tooling, embossing, application and plating, Casting: Rubber mold model, wax model from mold, Burn out wax, treatment of casting, Creating dye- Cutting by hand, plating, Forensic identification of fake coins	**09**
Unit-IV	**Examination of security documents** • Definition of security documents, security features and their types, examination of security features of: bank notes, passport, visa, stamp paper, lottery ticket, educational and financial documents • Video Spectral Comparator: principle and components, working mechanism	**09**
Unit-V	**Quality assurance in document examination** • Quality management in document laboratory, NABL guideline for accreditation of QD lab, report writing: expert intro, received document details, query, reason for opinion, opinion/report etc., importance of qualified opinion, no opinion, • Expert testimony: introduction, purpose, preparation for the trail in court, the sequence for examination of the expert: examination in chief, cross-examination, re-examination, Daubert guidelines, debonair of expert, limitation to the forensic questioned document examiner	**09**

Suggested Readings/Reference Books:

1. Tommie W. Singleton, Aaron J. Singleton – 2010 Fraud Auditing and Forensic Accounting.
2. Mark Nigrini - 2011 Forensic Analytics: Methods and Techniques for Forensic Accounting.
3. Joseph Petrucelli – 2013 Detecting Fraud in Organizations: Techniques, Tools, and Resources.
4. Mary-Jo Kranacher, Richard Riley, Joseph T. Wells – 2010 Forensic Accounting and Fraud Examination.
5. Steven L. Skalak, Thomas W. Golden, Mona M. Clayton – 2011 A Guide to Forensic Accounting Investigation
6. Larry E. Rittenberg, Karla M. Johnstone, Audrey A. Gramling – 2011 Auditing: A

Business Risk Approach
7. George A. Manning, Ph.D, CFE, EA - 2010 Financial Investigation and Forensic Accounting, Second Edition
8. Saurav K. Dutta – 2013 Statistical Techniques for Forensic Accounting
9. K. H. Spencer Pickett – 2010 The Internal Auditing Handbook
10. Joseph T. Wells – 2007 Corporate Fraud Handbook: Prevention and Detection
11. Walter J. Pagano, Thomas A Expert Witnessing in Forensic Accounting
12. Jack Bologna, Robert J. Lindquist - 1995 Fraud auditing and forensic accounting: new tools and techniques
13. Xenia Ley Parker, Lynford Graham – 2007 Information Technology Audits

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FOR/MJ/650P	Practical based on FOR/MJ/650T	Credit:01	Contact Hours:30	Marks:50

Course Overview

The practical course is based on the corresponding theory courses. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/650AP	Practical based on FOR/MJ/650AT	01	30	50
		OR			
2	FOR/MJ/650BP	Practical based on FOR/MJ/650BT	01	30	50
		OR			
3	FOR/MJ/650CP	Practical based on FOR/MJ/650CT	01	30	50
		OR			
4	FOR/MJ/650DP	Practical based on FOR/MJ/650DT	01	30	50
		OR			
5	FOR/MJ/650EP	Practical based on FOR/MJ/650ET	01	30	50

FOR/MJ/650AP	Practical based on FOR/MJ/650AT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Instrumentation in Forensic Physics** (FOR/MJ/650AT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Calibration and collection of spectra using Raman spectrophotometer.
2. Calibration and collection of spectra using FTIR spectrophotometer.
3. Calibration and collection of spectra using UV-Vis spectrophotometer.
4. Analysis of Raman spectra of a given material.
5. Analysis of FTIR spectra of a given material.
6. Analysis of UV-Vis spectra of a given material.
7. Elemental analysis of given material using Energy Dispersive X-ray Analysis (EDX).
8. Analysis of material on the basis of given XRD spectra.
9. Study of sensor parameters such as selectivity, sensitivity and response of various sensors.
10. Deposition of thick film sensors using screen printing method.
11. Deposition of thin film sensors using electrodeposition technique.
12. Detection and measurement of radiations using Gas filled detectors.
13. Study of output characteristics of semiconductor sensors.

14. Hall effect sensor for the detection and measurement of magnetic field.
15. Measurement of Hall parameters and conductivity and charge carrier density of given material using Hall effect
16. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/650BP	Practical based on FOR/MJ/650BT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Mobile Phone Forensics** (FOR/MJ/650BT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Setting up a Mobile Forensics Workstation
2. Familiarization with Mobile Forensics Software (e.g., Cellebrite, Oxygen Forensics)
3. Logical Acquisition from Android Devices
4. Analyzing Logical Acquisitions - Call Logs, SMS, Contacts, Applications
5. Advanced Analysis of Logical Acquisitions - Deleted Data Recovery, Hidden Artifacts
6. Creating Mobile Forensics Reports - Documentation of Acquisition, Analysis, Findings
7. Analyzing Application Data - Social Media, Browsing History
8. Troubleshooting Common Mobile Forensics Issues - Lock Bypassing, Tool Errors
9. Advanced Techniques - Password Cracking, Data Carving (may depend on software capabilities)
10. SIM Forensic
11. Call Details Record (CDR) analysis.
12. Static analysis of Mobile App (reverse Engineering)
13. Data Acquisition from an ordinary mobile phone
14. Analysis of extracted data in an ordinary mobile phone
15. Data Acquisition from Android Phones.
16. Analysis of extracted data in Android Phones.
17. Data Acquisition from iOS devices
18. Analysis of extracted data in iOS devices.
19. Screen locking bypass / Password Cracking of Mobile Phones.
20. Dynamic analysis of Mobile App
21. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/650CP	Practical based on FOR/MJ/650CT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **DNA Forensics** (FOR/MJ/650CT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Isolation and characterization of microbial Plasmids for identification
2. DNA– Isolation from bones
3. DNA– Isolation from teeth
4. DNA– Isolation from saliva/hair root/ seminal stains/nails Restriction digestion of DNA from above samples.
5. PCR– amplification of DNA
6. Polyacrylamide gel electrophoresis and silver staining.
7. Differential centrifugation/ extraction for separation of epithelial cell from sperm
8. DNA fingerprinting for testing of paternity disputes and rape cases.
9. To Perform RFLP and RAPD
10. Western blotting
11. Northern Blotting
12. Problems on population genetics (Frequency estimates, Likelihood ratio, Paternity index)
13. Visit Autopsy centre at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Centre, Biodiversity and wildlife Centre.
14. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/650DP	Practical based on FOR/MJ/650DT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Chemistry of Food and Industrial Products** (FOR/MJ/650DT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Detection of adulteration in milk using color tests (10-12 Spot/Color Test)
2. Analysis of nail paint by UV-Visible spectroscopy and TLC
3. Analysis of dyes (methyl orange/ methylene blue / methyl red) using UV-Visible spectroscopy and TLC
4. Analysis of dye and pigments by using TLC technique (minimum two)
5. Analysis of adulterated and non-adulterated oil by chemical/Color Test and TLC method
6. Analysis of dye in petrol and kerosene by UV spectrophotometry and TLC
7. Identification of adulterants in some common food samples by chemical methods/color test
8. Analysis of adulterated and non-adulterated oil by chemical/Color Test and TLC method
9. Analysis of country liquor by color tests.
10. Detection of alcohol in the urine sample
11. Analysis of alcohol content in sample by derivatization into known organic Compounds.
12. Extraction of alcohol from blood sample and analysis by color test
13. Analysis of adulterated cement
14. Report submission on Industry/ Laboratory visit
15. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/650EP	Practical based on FOR/MJ/650ET	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Advanced Document Examination** (FOR/MJ/650ET). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To examine security features of a bank note of a specific denomination
2. To examine security features of passport
3. To examine security features of a VISA
4. To compare security features of Indian bank notes with other countries
5. To compare security features of Indian passport with other countries
6. To study stylistics features of the given handwriting samples
7. To compare two handwriting samples for their comparison based on stylistics features
8. To identify regional styles based on handwriting
9. To identify anomalies in a financial document
10. To identify fake coins
11. To submit report on visit to numismatic institute/bank note press
12. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/651T	Special Paper-V	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course has been designed to get the students specialized in a particular domain of forensic science. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/651AT	Fire and Arson Investigation	03	45	75
		OR			
2	FOR/MJ/651BT	Malware Analysis	03	45	75
		OR			
3	FOR/MJ/651CT	Wildlife Forensics and Entomology	03	45	75
		OR			
4	FOR/MJ/651DT	Forensic Toxicology-II	03	45	75
		OR			
5	FOR/MJ/651ET	Advanced Fingerprint Forensics	03	45	75

FOR/MJ/651AT	Fire and Arson Investigation	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of fire and arson investigation

Course Objectives

The course has the following objectives:

- Students will gain an idea of thermodynamics
- Students will learn fire and explosion deaths and injuries
- Students will have an understanding of motor vehicle fire
- Students will understand the concepts of wildfire investigation
- Students will learn management of complex fire investigation

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to fire and arson investigation
- CO2: Apply thermodynamics in fire investigation
- CO3: Analyze evidence related to fire scene investigation
- CO4: Compare various fire scenario
- CO5: Analyze complex fire investigation

Unit	Course Content	Contact Hours

Unit-I	**Thermodynamics** • Introduction and overview, relevant background of physical thermodynamics, role of thermodynamics in fire investigation, Fire: ignition and propagation, thermodynamic classification of ignition sources, smoldering, flames, types of fire, sources of ignition, auto ignition, direct ignition, match of cigarette lighter, time-delay ignition devices, fire development	09
Unit-II	**Fire and explosion deaths and injuries** • Flammable and combustible liquids, compressed gas cylinders, temporary heating devices, chemical tanks or drums, liquefied petroleum gas, explosives and blasting agents, vehicles and heavy equipment, appliances, classification of explosives blast injuries, selected blast injuries, nature of fire investigations, systematic approach, relating fire investigation to the scientific method, case review: BPCL blast in Mumbai	09
Unit-III	**Motor vehicle fire** • Investigating automobile fire causes, the fuel system, the electrical system, near the hood, Inspect the scene of the fire	09
Unit-IV	**Wildfire Investigation** • Wildfire investigations: fire behavior, principles of fire spread, factors, fire direction indicators, general principles of burn pattern interpretation, indicator categories, systematic methodology, use of scientific method, basic method of fire investigation, planning the investigation, specialized personnel and technical consultants, fire scene evidence, collection and preservation procedures, photography technique in fire	09
Unit-V	**Management of complex fire investigations** • Introduction, fire investigating safety, fire scene hazards, investigator priorities upon arrival at the scene: fires in port, colour of flames and smoke, scene security, fire scene examination, reconstruction of fire cause, sketching, marine fire investigations	09

Suggested Readings/Reference Books:

1. Fire investigator: principles and practice, 4th edition, Jones and Bartlett
2. NFPA 1033 "Professional Qualifications for fire investigator", 2014 edition
3. NFPA 921 "Guide for fire and explosion investigations" 2014 edition
4. Explosions and blast injuries: A primer for clinicians, CDC injury prevention, Dept. of

health and human services. USA (primer.pdf)
5. Chapter 4 basic methodology: https://www.npfa.org
6. Fire and explosion investigations- A historical and hysterical perspective, John A. Campbell, P.E. and Kim R. MniszewskiP.E.Triodyne Inc., December 1991, volume 7, no.2, ISSN 1041-9489 (SB_V7N2.PDF)
7. Investigating automobile fire causes, Glen A. Shifflett, Journal of criminal law and criminology, 1958, volume 49, issue 3, article 14. (Investigation Automobile Fire Causes.pdf)
8. Automobile arson investigations, William J. Davis, Journal of criminal law and criminology, 1946, volume 37, issue 1, article 8. (Automobile Arson Investigations.pdf)
9. Wildfire origin and cause determination handbook, NWCG Handbook 1, PMS 412-1, May 2005 (480333.pdf)
10. Guide-for-conducting-Marine-Fire-Investigation-chapter 4: fire scene investigation, https://maiif.org>uploads>2017/08
11. Encyclopedia of forensic sciences, volume 3, edited by Jay Siegel, G. Knupter, PekkaSaukko, Elsevier

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FOR/MJ/651BT	Malware Analysis	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of malware analysis

Course Objectives

The course has the following objectives:

- Students will gain an idea of malware analysis
- Students will learn and analyze various types of malware
- Students will have an understanding of static and dynamic analysis
- Students will understand the concepts of debugging
- Students will learn the concepts of memory forensics in malware analysiss

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to mobile forensics
- CO2: Apply various techniques for static and dynamic analysis of malware
- CO3: Analyze malicious binaries and debugging
- CO4: Compare various malware obfuscation techniques
- CO5: Analyze the concepts of memory forensics in malware analysis

Unit	Course Content	Contact Hours
Unit-I	**Introduction to malware analysis** • Malware: General Aspect of Computer infection program, Non-Self Reproducing Malware, how does Virus Operate? Virus nomenclature, Worm Nomenclature, Recent Malware Case Studies, What Is Malware Analysis, Why Is Malware Analysis, Types of Malware Analysis. • Static Analysis: Determining the File Type, fingerprinting the Malware, Multiple Anti-Virus Scanning, Extracting Strings, Determining File Obfuscation, Inspecting PE Header information, Comparing and Classifying the Malware, Classifying Malware using YARA, Reverse engineering Android apps	09
Unit-II	**Dynamic analysis and disassembly** • Dynamic Analysis: Dynamic Analysis (Monitoring) Tools, Dynamic Analysis Steps, Analyzing a Malware Executable, Dynamic-Link Library (DLL) Analysis, Cuckoo Sandbox • Disassembly: How Data Resides in Memory, Program Compilation, Program on Disk, Program in	09

	Memory, Program Disassembly (From Machine code To Assembly code), Analyzing 32-bit Executable on 64-bit Windows, Disassembly Challenge, Disassembly Solution, • Disassembly Using IDA: Code Analysis Tools, Static Code Analysis (Disassembly) Using IDA, Disassembling Windows API, Patching Binary Using IDA, IDA Scripting and Plugins	
Unit-III	**Debugging** • Debugging Malicious Binaries: General Debugging Concepts, debugging a Binary Using x64dbg, debugging a Binary Using IDA, Debugging a .NET Application • Malware Functionalities and Persistence: Malware Functionalities, Malware Persistence Methods • Code Injection and Hooking: Virtual Memory, User Mode and Kernel Mode, Code Injection Techniques, Hooking Techniques	**09**
Unit-IV	**Malware obfuscation techniques** • Malware Obfuscation Techniques: Simple Encoding, Malware Encryption, Custom Encoding/Encryption, Malware Unpacking • Hunting Malware Using Memory Forensics: Memory Forensics Steps, Memory Acquisition, Volatility Overview, Enumerating Processes, Listing Process Handles, Listing DLLs, Dumping an Executable and DLL, Listing Network Connections and Sockets, Inspecting Registry, Investigating Service, Extracting Command History	**09**
Unit-V	**Detecting Advanced Malware Using Memory Forensics** • Detecting Code Injection, Investigating Hollow Process Injection, Detecting API Hooks, Kernel Mode Rootkits, Listing Kernel Modules, I/O Processing, Displaying Device Trees, Detecting Kernel Space Hooking, Kernel Call-backs and Timers	**09**

Suggested Readings/Reference Books:

1. ErciFiliol, "Computer Viruses: from theory to applications", Springer, 1st edition,2005.
2. Monnappa K.A., "Learning_Malware_Analysis: Explore the concepts, tools, and technique to analyse and investigate Windows malware", Packt Publishing Ltd, 1st
3. edition ,2018
4. Michael Sikorski and Andrew Honig, "Practical Malware Analysis", No starch press-February, 2012.
5. Mark. A.Ludwig,"The Giant black book of computer viruses,CreateSpace Independent Publishing Platform, 2ndedition, 2009,ISBN 10: 144140712X

6. Ken Dunham , Shane Hartman,Jose Andre Morales,Manu Quintans ,Tim Strazzere, Android Malware and Analysis, CRC Press
7. Bruce Dang, Alexandre Gazet, Elias Bachaalany, Sébastien, Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation",Wiley publication
8. Mobile Malware Attacks and Defense, Ken Dunham, Syngress Publishing,Inc.,ISBN978-1-59749-298-0:

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FOR/MJ/651CT	Wildlife Forensics and Entomology	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of wildlife forensics and entomology

Course Objectives

The course has the following objectives:

- Students will gain an idea of endangered species
- Students will learn about wildlife forensics
- Students will have an understanding of forensic analysis of wildlife evidence
- Students will understand the concepts of forensic entomology
- Students will learn the concepts of PMI from entomological forensics

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to wildlife forensics
- CO2: Apply various techniques to analyze wildlife evidence
- CO3: Analyze various entomological evidences
- CO4: Compare properties of various insects
- CO5: Analyze the postmortem interval from insects

Unit	Course Content	Contact Hours
Unit-I	**Endangered Species** • Importance of wildlife and Environment, Protected and endangered species, Sanctuaries and their importance, Red-data book. Relevant provision of wildlife and environmental act: Enforcement of wildlife protection policy, Wildlife Protection Act 1972, Forest Conservation Act 1981, Environment (protection) Act 1986.	09
Unit-II	**Wildlife Forensics** • Types of wildlife crimes, different methods of killing and poaching of wildlife animals, Types of wildlife investigations, Applications of Forensic Ornithology, Feather structure, and topography. Application of forensic science to wildlife investigation, recovering evidence at poaching scenes, Locating the burial: Anomalies on the surface international trade in reptile skins.	09
Unit-III	**Forensic analysis of wildlife evidence** • Hair examination for racial determination. Identification of Pugmarks of various animals census	09

	of wildlife population. Development of wildlife forensic laboratories and identification of wild life materials by conventional and modern methods. Genetic methodologies in wildlife investigation	
Unit-IV	**Forensic Entomology-I** • Characteristics and Identification of insects, Insects of forensic significance, • Collection of entomological evidence, meteorological data, Dipterans Larval Development, Successional colonization, displacement and disturbance, impact of Drugs, Human & Animal neglect or abuse	**09**
Unit-V	**Forensic Entomology-II** • Time elapsed since death (TSD), Determination of post mortem interval PMI. Determining the age of blow fly life cycle stages by ADH/ADD/ Isomegalen diagram method. Case studies. Laboratory rearing of forensic insects.	**09**

Suggested Readings/Reference Books:

1. Concept in wildlife Management, Hosetti, B.B Daya publishing 103House
2. Forensic science in wild life investigation, Linarce, Adrian CRC Press, Taylor & Francis
3. The wild life (protection) act, Baalu, T.R.1972, Nataraj Publication
4. Wild life (Protection act, 1972), Universal Publication
5. Wildlife protection act, 1972; Natraj Publishers
6. Timber Identification, N. Clifford; Leonard Hill ltd.,
7. A manual of wood identification, Herbert L. Edlin Viking Press,
8. Man-made fibres, R.W. Moncrieff Newness butter worth
9. Forensic botany, Coyle, Heather Miller CRC Press,
10. College botany, Gangulee, Hirendra Chandra New Central Book Agency,
11. Plant anatomy, Esau, Katherine Wiley Eastern Ltd,
12. Plant anatomy, Chandurkar, P J Oxford & IBH Publishing Co,
13. Systematic botany for degree students, Singh, Jagjit S Chand & Co.,
14. The poisonous plants, H.C. Long Asiatic Publishing House,
15. Plant Anatomy, B.P. Pandey S. Chand& Co., New Delhi, (1998)
16. Environmental Law- The Law & policy relating to protection of environment, Ball Simon Universal Law Pub Co, Delhi,
17. Environmental Forensic Principles and Applications, Morrison Robert D, CRC Press, NY
18. Forensic Entomology: Jason H Byrd & James L Castner
19. Insect Biology: Hovard Evan
20. Fundamentals of Entomology, Richard J. Flzinga Prentice hall of India pvt ltd, (1978)

21. Entomology & death- A procedural guide, Catts E.P & Haskell NH; Joyce's print shop (1990)
22. A manual of Forensic Entomology Smith DGV; Ithaca NY Camstock Univ. Press, USA (1986)
23. General text book of Entomology, O.W. Richards & R.G. Davis; Chapman & hall ltd, (1973)

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FOR/MJ/651DT	Forensic Toxicology-II	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of forensic toxicology including plant poisons, food poisons, animal poisons, and corrosive poisons

Course Objectives

The course has the following objectives:

- Students will gain an idea of plant poisons
- Students will learn and analyze food poisons
- Students will have an understanding of environmental and nano-toxicology
- Students will understand the concepts of corrosive poisons
- Students will learn the concepts of animal poisons

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to poisons
- CO2: Apply various techniques to analyze food poisoning
- CO3: Analyze various corrosive poisons
- CO4: Compare properties of animal poisons
- CO5: Analyze the characteristics of environmental and nano-toxicology

Unit	Course Content	Contact Hours
Unit-I	**Plant poison** • Introduction, active constituents, signs and symptoms, fatal dose, fatal period, postmortem appearance of the following: o Neurotic: *Atropa belladonna, Dhatura fastuosa, Strychnos, Nux vomica* o Cardiac: *Aconitum napellus, Digitalis purpurea, Cerbera thevetia* o Irritant: *Abrus precatorius, Calotropis gigantea, Croton tiglium, Argemone mexicana, Ricinus communis.* • Extraction and stripping of plant poisons from various matrices using Stas-Otto, modified Stas-Otto, ammonium sulfate methods, other methods and their subsequent identification using color tests and instrumental techniques such as FT-IR, NMR, HPLC, LC-MS, GC, GC-MS and tandem techniques	09
Unit-II	**Food poisoning**	09

	• Introduction, Food poisoning due to chemical, bacterial and fungal, Sign and symptoms of food poisoning • Collection and preservation of evidence material • Extraction and isolation, from food material, biological material, • Detection and identification by colour test and instrumental techniques	
Unit-III	**Animal poisons** • Introduction, nature, signs and symptoms, fatal dose, fatal period and postmortem appearance of animal toxins due to the following: Cantharides, scorpion, spiders and poisonous insects: ants, bees, wasps. • Snakes: Classification of snakes; snake venom: composition, sign and symptoms, fatal dose, fatal period, postmortem appearance, mode of action; treatment of snakebite and tests for identification. • Forensic Significance, Related Case studies	**09**
Unit-IV	**Corrosive poisons** • Introduction, signs and symptoms, fatal dose, fatal period and postmortem appearance of the following: • Inorganic acids: Sulphuric acid, nitric acid, hydrochloric acid, hydrofluoric acid, boric acid. • Organic acids: Oxalic acid, carbolic acid, salicylic acid, acetic acid, formic acid • Alkalies: Ammonia, sodium hydroxide, potassium hydroxide • Extraction of acid and alkalies from various biological matrices and their identification and quantification. • Forensic Significance, Related Case studies	**09**
Unit-V	**Environmental and Nano-toxicology** • Environmental toxicology: Study of environmental toxicology, recent worldwide development, and environmental pollution Importance of environmental toxicology, Assessment of toxicity, Toxicity at the molecular level (Carcinogenesis, Genotoxicity assays), and Effect Toxicants. • Nano-toxicology: Introduction to nano-waste, sources of toxicity, routes of administration, factors affecting toxicity, health hazards, methods of analysis, prevention and safety measures, forensic significance.	**09**

Suggested Readings/Reference Books:

1. Bamford F.; Poisons: Their Isolation and Identification, (3rd Edition); McGraw-Hill Press, 1955
2. Modi, Jaisingh, P.; Textbook of Medical Jurisprudence& Toxicology, M.M. Tripathi Publication (2001)
3. Clarke E.G.C. and Moffat A.C.; Clark's Isolation and Identification of Drugs (Edition 2 revised); Publisher Pharmaceutical Press. 1986
4. "Working Procedure Manual on Chemistry", Directorate of Forensic Science MHA Govt. of India, 2005.
5. Arena J.M. (3rd Edition) (1974), Poisoning: Toxicology, Symptoms treatments, Thomas: University of California.
6. Burcham Philip C (2013) ; An introduction to toxicology; 1st edition; Springer Publication; New York;
7. Christian Donell R (2004); Forensic Investigation Of Clandestine Investigation; 1st Edition; CRC Press; New York
8. Connors, K.A. (1975), A Text book of Pharmaceuticals analysis, Wiley Interscience, New York.
9. Curry A.S. (1972), Advances in Forensic and Clinical Toxicology, CRC Press.
10. Curry A.S. (Part II) (1986), Analytical Methods in Human Toxicology, Publisher Wiley Verlag Chemie.
11. Flanagan Robert J., Taylor A, Watson Ian D, Whelpton Robin (2008); Fundamental of analytic toxicology; 1st Edition; Wiley; London
12. Hayes A Wallace, Kruger L. Claire; Haye's (2014): principles and methods of toxicology; 6th Edition; CRC Press; New York.
13. Hodgson Ernst (2011); A textbook of modern toxicology; 3rd Edition, John Wiley & Sons, Inc. Publication; Canada
14. Holfmann, F.G. (1975), A Handbook of Drug and Alcohol Abuse, New York: Oxford University Press.

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FOR/MJ/651ET	Advanced Fingerprint Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of fingerprint forensics including the origin, advanced development techniques, classification and comparison methods

Course Objectives

The course has the following objectives:

- Students will gain an idea of origin and classifications of fingerprints
- Students will learn and analyze fuming techniques on fingerprint development
- Students will have an understanding of chemical techniques on fingerprint development
- Students will understand the concepts of various classification methods
- Students will learn the concepts of related techniques in fingerprint examination

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to fingerprint forensics
- CO2: Apply fuming method for fingerprint development
- CO3: Analyze chemical techniques on fingerprint development
- CO4: Compare various classification methods
- CO5: Analyze comparative method for examination of fingerprints

Unit	Course Content	Contact Hours
Unit-I	**Origin and classifications of fingerprints** • Anatomy of human skin, morphogenesis of friction ridge skin-primary and secondary ridge formation, volar pad development, differentiation of friction ridges, pattern formation, factors affecting ridge formation, effect of timing and symmetry on ridge formation, role of genetics, persistence of ridges-aging, wound healing. • Secretory glands: Eccrine (Inorganic, Organic etc.), Sebaceous (Fatty acids, Phospholipids, Wax esters, Sterols, Squalene etc.) and Apocrine. Variation of secretion with age. • Composition of Latent Print residue by different agencies (UK Home Office, Oak Ridge National Library, Pacific Northwest National Library, Savannah River Technical Center research, Forensic Science Services, etc).	09
Unit-II	**Fuming and Optical detection techniques** • Principle, chemistry & mechanism, pretreatments, reagent application, limitations, environmental	09

	conditions, fixation and enhancement, applications: Iodine fuming, Cyanoacrylate fuming (vacuum, atmospheric, fluorescent CA fuming), Hydrogen fluoride, osmium/ruthenium tetroxide, soot method, disulphur dinitride. • Alternate light sources: luminescence diffused reflection and reflected UV imaging. • Metal deposition techniques: Principle, mechanism, pretreatments, reagent application, limitations, environmental conditions, fixation and enhancement, applications: vacuum metal deposition, multi metal deposition.	
Unit-III	**Chemical Techniques** • Principle, chemistry & mechanism, pretreatments, reagent application, limitations, environmental conditions, fixation and enhancement, applications: Silver nitrate, Ninhydrin and its analogs, DMAC, physical developers and SPR. • Development of prints on challenging surfaces (thermal paper, gloves, guns, cartridges, wet surfaces, adhesive tape, and skin). Enhancement of bloody prints. Effect of fingerprint detection techniques on subsequent DNA profiling. Age estimation of latent prints.	**09**
Unit-IV	**Classification and Examination** • Classification systems: Johannes Purkinje, tripartite classification, Argentine system, Henry's classification, Battley single fingerprint system, NCIC. • Fundamentals of comparison: print-to-print, trace-to-record, trace-to-print, trace-to-trace comparison. ACE-V examination method, documentation (Primary, secondary & tertiary custody documentation).	**09**
Unit-V	**Related Techniques** • Palm prints: Cumins and Midlo classification systems and its significance. • Edgeoscopy: Chatterjee classification • Poroscopy: Significance in personal identification	**09**

Suggested Readings/Reference Books:

1. E. Roland Menzel; Fingerprint Detection with Loseres; Second edition; Marcel Dekker, Inc.1999.
2. Fingerprint and other ridge skin impressions, Christophe Champod, Chris J. Lennard, Pierre Margot, Milutin Stoilovic

3. James F. cowger; Friction Ridge skin CRC Press London, 1993.
4. Cummins & Midlo : Finger Prints, Palms and Soles, 1943, The Blakiston office London.
5. Moenssens : Finger Prints Techniques, 1975, Chitton Book Co., Philadelphia, New York.
6. Allison : Personal Identification.
7. Chatterjee S.K. and Hagne R.V. (1988) : Finger Print or Dactyloscopy and Ridgeoscopy.
8. H.C. Lee and R.E. Gaensslen eds "Advances in Fingerprint Technology", second ed.,New York: CRC Press, 2001.
9. The fingerprint sourcebook, US Department of Justice.
10. Quantitative – Qualitative Friction ridge Analysis. David R. Ashbough. By CRC Press LLC 1999.
11. The Science of Fingerprints. Federal Bureau of Investigation. Rev. 12-84 by U.S. Government Printing Office Washington D.C.
12. Bailey's Textbook of Histology 16th Edition pg. 366 – 377.
13. Poroscopy, Identification News November 1982. D.R. Ashbaugh CPL pg 3-8.
14. Ridgeology, Journal of forensic Identification. 16/41 (1) 1991 by David R. Ashbaugh.

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FOR/MJ/651P	Practical based on FOR/MJ/651T	Credit:01	Contact Hours:30	Marks:50

Course Overview

The practical course is based on the corresponding theory courses. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/651AP	Practical based on FOR/MJ/651AT	01	30	50
		OR			
2	FOR/MJ/651BP	Practical based on FOR/MJ/651BT	01	30	50
		OR			
3	FOR/MJ/651CP	Practical based on FOR/MJ/651CT	01	30	50
		OR			
4	FOR/MJ/651DP	Practical based on FOR/MJ/651DT	01	30	50
		OR			
5	FOR/MJ/651EP	Practical based on FOR/MJ/651ET	01	30	50

FOR/MJ/651AP	Practical based on FOR/MJ/651AT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Fire and Arson Investigation** (FOR/MJ/651AT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Forensic examination of ignition and propagation of fire.
2. Determination of origin and cause of fire.
3. Forensic documentation of fire and arson crime scene using Photograph/Videotape.
4. Forensic documentation of fire and arson crime scene using sketching.
5. Collection and preservation of physical evidence in fire and arson cases.
6. Forensic investigation of burning of residential/ non-residential buildings.
7. Forensic investigation of burning of wood, fences, corn, grain, trees.
8. Forensic investigation of causes of automobile fires.
9. Forensic investigation of Fire debris sample such as gasoline on a charred matrix of carpet and carpet padding.
10. Quantification of Fuel and Air Content of Combustible Mixtures.
11. Measurements of the Flame Speed.
12. Forensic examination of the fuel system and the electrical system of Motor vehicles.
13. Forensic examination of fire investigating safety.

14. Examination of fire scene hazards at buildings.
15. Determination of temperature from color of flames and smoke.
16. Examination and interpretation of burn pattern in different fire and arson cases.
17. Examination and interpretation of burn injuries in different fire and arson cases.
18. Report writing of fire and arson cases.
19. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/651BP	Practical based on FOR/MJ/651BT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Malware Analysis** (FOR/MJ/651BT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Set up a safe virtual environment to analyze malware
2. Quickly extract network signatures and host-based indicators
3. Use key analysis tools like IDA Pro, OllyDbg, and WinDbg
4. Overcome malware tricks like obfuscation, anti-disassembly, anti-debugging, and anti-virtual machine techniques
5. Use your newfound knowledge of Windows internals for malware analysis
6. Develop a methodology for unpacking malware and get practical experience with five of the most popular packers **[Five experiments]**
7. Analyze special cases of malware with shellcode, C++, and 64-bit code
8. Install Reanimator in your Windows machine and scan the system for Malware and prepare one report for the same.
9. Ransom ware Analysis
10. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/651CP	Practical based on FOR/MJ/651CT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Wildlife Forensics and Entomology** (FOR/MJ/651CT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Collection, identification and preservation of entomological evidence
2. Collection of wildlife samples
3. Laboratory study of collected wildlife samples
4. Laboratory rearing of forensically significant insects.
5. Impact of drugs and toxins on insect development
6. Study of successional colonisation of insects in different environments
7. Identification of orders of insects and other arthropods of forensic significance.
8. Study of pugmarks of animals
9. Identification of birds from feathers.
10. Examination of fur, nails, horn, teeth
11. Examination of hair of different animals such as Dogs, Cats, Cow, Horse, Goats etc.
12. Determination of human hair morphology
13. DNA Typing of wildlife species
14. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/651DP	Practical based on FOR/MJ/651DT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Toxicology-II** (FOR/MJ/651DT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Analysis of animal poisons using TLC.
2. Analysis of blood, urine, stomach wash in emergency cases of poisoning **(minimum three)**
3. Analysis of food material in case of food poisoning by chemical, and instrumental techniques **(minimum two)**
4. Analysis of viscera in case of food poisoning by chemical, and instrumental techniques **(minimum two)**
5. Extraction of ionic poisons (Anionic and cationic) from given samples by using dialysis and identification by color test **(minimum three)**
6. Extraction of toxic anions from viscera samples and analysis by colour tests.
7. Synthesis of metal nanoparticles by chemical methods and identification by UV-VIS spectroscopy.
8. Identification of vegetable poisons of Forensic interest
9. Identification of plant poisons by microscopic methods
10. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/651EP	Practical based on FOR/MJ/651ET	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Advanced Fingerprint Forensics** (FOR/MJ/651ET). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To develop latent prints by Cyanoacrylate fuming
2. To develop latent prints by SPR method
3. To develop fingerprints on challenging surfaces
4. To enhance the bloody fingerprint
5. To visualize latent fingerprint using alternate light source
6. To study the effect of environment on fingerprint development
7. To classify fingerprint cards by FBI Henry's classification system
8. To classify fingerprint cards by Indian Henry's classification system
9. To classify fingerprint card by NCIC classification system
10. To classify fingerprint cards by Argentine classification system
11. To compare chance prints with a known print
12. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/652T	Special Paper-VI	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course has been designed to get the students specialized in a particular domain of forensic science. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/652AT	Forensic Audio and Video Analysis	03	45	75
		OR			
2	FOR/MJ/652BT	Machine Learning and Multimedia Forensics	03	45	75
		OR			
3	FOR/MJ/652CT	Microbial Forensics	03	45	75
		OR			
4	FOR/MJ/652DT	Spectroscopy	03	45	75
		OR			
5	FOR/MJ/652ET	Multimedia Forensics and Biometrics	03	45	75

FOR/MJ/652AT	Forensic Audio and Video Analysis	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of forensic audio and video analysis

Course Objectives

The course has the following objectives:

- Students will gain an idea of physics of voice authentication
- Students will learn forensic linguistics and discourse analysis
- Students will have an understanding of various techniques of speaker identification
- Students will understand the concepts of forensic video analysis
- Students will learn analysis and interpretation of video evidence

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to audio and video analysis
- CO2: Apply forensic linguistics in speaker identification
- CO3: Analyze evidence related to CCTV
- CO4: Compare various video formats
- CO5: Analyze and interpret video evidence

Unit	Course Content	Contact Hours
Unit-I	**Physics of voice authentication** • Physics of sound: waves and sound, analysis and synthesis of complex waves, Human and non-human utterances, anatomy of vocal tract, vocal formants, analysis of vocal sound, frequencies and overtones Electronics of audio recording, Transmission and playback devices, noise and distortion, voice storage and preservation	09
Unit-II	**Forensic Linguistics and Discourse Analysis** • Forensic Linguistics: Phonetics, Morphology, Syntax, Semantics, Stylistics, Pragmatics, Script, orthography and graphology, Difference between language and speech, Psycholinguistics, Neurolinguistics, Sociolinguistics, Scientific approaches; Reliability and admissibility of evidence in the court, linguistic profile, language register • Discourse Analysis: Connivance, acceptance, listening feedback and rejection in the context of Mens-Rea, Narrative, Dialectology, Linguistic variety as a geographical marker, Idiolects and speaker characterization, Phonology, Morphology and Word formation processes as individual linguistic abilities	09
Unit-III	**Various approaches in Forensic Speaker Identification** • Instrumental Analysis of speech sample, Interpretation of result, Statistical interpretation of probability scale, Objective/Subjective methods, discriminating tests, closed test, open test, likelihood ratio calculation, Concept of test and error in Speaker Identification, case studies. Techniques and Best Practices for examination of Audio recording authentication and case studies. Automatic speaker identification and verification system based on fuzzy logics, neural network, MPCC etc., Voice Biometrics VoIP and other modes of speech communication and their forensic analysis	09
Unit-IV	**Forensic Video Analysis** Introduction to video technology: electronic photography, scanning, synchronizing the analog signal, Digital signal processing, color video, Digital television standard, HD Video, digital scopes, compression, image acquisition and recording formats, optical media, time code, audio for video, displays, Types of video Camera, Basics of CCTV, scope recognizing CCTV evidence & its nature, types of DVRs, DVR recording, evidence, best practices of	09

	CCTV evidence retrieval and storage at scene of crime and laboratory, challenges and precaution at the scene of crime, evidence handling procedure, legal issues, recommended equipment needed. Watermarking, Interlacing, De-interlacing, Double Compression, Duplication, Reprojection.	
Unit-V	**Analysis and interpretation of video evidence** Best practices of collection, recovery, enhancement, analysis and interpretation of video evidence Facial image recognition, vehicle registration plate image enhancement, foreign object detection, Authentication of Video evidence, video source identification techniques. Case studies.	**09**

Suggested Readings/Reference Books:

1. Principles of Forensic Audio Analysis (Modern Acoustics and Signal Processing) Hardcover – 15 November 2018 by Robert C. Maher
2. Digital Audio Forensics Fundamentals by Zjalic James CRC Press
3. Forensic Analytics by Nigrini Mark J. John Wiley & Sons Inc
4. Principles Of Forensic Audio Analysis by MAHER R C, SPRINGER
5. Multimedia Forensics and Security by Abdul Ella Hassanien Springer International Publishing AG
6. Forensic Speaker Recognition Amy Neustain, Hemant A. Patil Springer
7. Practical Forensic Imaging Nikkel, Bruce San Francisco, CA

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FOR/MJ/652BT	Machine Learning and Multimedia Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of machine learning and multimedia forensics

Course Objectives

The course has the following objectives:

- Students will gain an idea of machine learning
- Students will learn and analyze various types of image forgeries
- Students will have an understanding of audio forensics
- Students will understand the concepts of video forensics
- Students will learn the concepts of face recognition

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to mobile forensics
- CO2: Apply various techniques for image forgery detection
- CO3: Analyze CCTV and video evidences
- CO4: Compare characteristics of various video files for forgery detection
- CO5: Analyze attributes of faces for reegnition

Unit	Course Content	Contact Hours
Unit-I	**Machine Learning** • Machine Learning: Introduction, Taxonomy of Machine Learning, concepts of learning: supervised, unsupervised and reinforced learning. Classification and clustering. • Classification Techniques: o Bayesian Theory of Decision: Introduction, Bayes Decision Rule, Bayes Classifier, Loss Function, Zero-One Loss Function, Discriminant Functions, Gaussian Density, Discriminant Functions for Gaussian Likelihood, Receiver Operating Curves. o K-Nearest Neighbour, Support Vector Machine, Artificial Neural Network • Clustering Methods: Expectation Maximization Algorithm, Basic Notions and Terminology-Means, Self-Organizing Maps, Neural Gas and Topology Representing Network, General Topographic Mapping, Fuzzy Clustering Algorithms.	09
Unit-II	**Image Forensics**	09

	• Introduction and scope of image forensics, Source Identification: overview of image source identification, digital camera and image sensors, identification based on sensor defects and physical defects. Authentication of image evidence: image tampering and its type, detection of image tampering based on scene, optics, sensor, processing and image property. • Steganography and digital watermarking: introduction and scope of steganography and digital watermarking, comparative study steganography and digital watermarking, basic concepts of steganography and digital watermarking models, basic concepts of digital watermarking security and steganalysis.	
Unit-III	**Video Forensics** • Basics of CCTV, scope recognizing CCTV evidence & its nature, types of DVRs, DVR recording, evidence, best practices of CCTV evidence retrieval and storage at scene of crime and laboratory, challenges and precaution at the scene of crime, evidence handling procedure, legal issues, recommended equipment needed. Watermarking, Interlacing, De-interlacing, Double Compression, Duplication, Reprojection	**09**
Unit-IV	**Video Forensics and Face Recognition** • Authentication of Video evidence, video source identification techniques • Face recognition: Introduction, Face Detection and Localization, Lighting Normalization, Feature Extraction, Classification, Performance Assessment	**09**
Unit-V	**Audio Forensics** • Audio Acquisition, Representation and Storage: Sound Physics, Production and Perception, Audio Acquisition, Audio Encoding and Storage Formats, Time-Domain Audio Processing. • Speech Recognition: Introduction, Speech sounds, Speech waves, Spectral representation, the acoustic theory of speech representation, the perception The Front representation, the Training, Recognition and Performance Measures, Recognition Experiments, Speech Recognition Results, Applications.	**09**

Suggested Readings/Reference Books:

1. Machine Learning for Audio, Image and Video Analysis - Theory and Applications by

Nicu Sebe, Ira Cohen, Ashutosh Garg, Thomas S. Huang (z-lib.org) .
2. Forensic Speaker Identification,Philip Rose
3. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Prentice-Hall, Inc. Upper Saddle River, NJ, USA, 2006
4. Alan Bovik, Handbook of Image and Video Processing, Academic Press, USA, 2000
5. Husrev Taha Sencar and Nasir Memon, Digital Image Forensics: There is More to a Picture than Meets the Eye, Springer Science and Business Media, New York, 2013
6. Anthony T.S. Ho and Shujun Li, Handbook of digital forensics of multimedia data and devices, John Wiley & Sons, Ltd., UK, 2015.
7. Hany Farid, Photo Forensics, The MIT Press, Cambridge, First Edition, 2016
8. Forensic Analytics by Nigrini Mark J. John Wiley & Sons Inc
9. Principles Of Forensic Audio Analysis by MAHER R C, SPRINGER
10. Multimedia Forensics and Security by Abdul Ella Hassanien Springer International Publishing AG

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FOR/MJ/652CT	Microbial Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of microbial forensics.

Course Objectives

The course has the following objectives:

- Students will gain an idea of microbial diversity
- Students will learn and analyze microbes
- Students will have an understanding of biological warfare agents
- Students will understand the concepts of diagnosis and tracking microbial disease
- Students will learn the concepts of laboratory quality management and safety

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to microbial forensics
- CO2: Apply various techniques to analyze microbial evidence
- CO3: Analyze various biological warfare agents
- CO4: Compare properties of various microbes
- CO5: Analyze quality measures in a microbial laboratory

Unit	Course Content	Contact Hours
Unit-I	**Microbial diversity** • Types of microbes: Bacteria, virus, fungi, algae. Morphological, biochemical differences. Growth curve and sporulation. Secondary metabolites: Toxins and antibiotics production. Drug resistance and clinical concern	09
Unit-II	**Microbial Identification Methods** • Morphological identification, Biochemical identification, Molecular identification methods, Microbial profiles as identification tools, Microbial forensic programs (SWGMGF).	09
Unit-III	**Biological Warfare Agents** • Bioterrorism, Centers for disease control and protection (CDC), Warfare agents category A, B, C. Potential microbes and their toxins, mode of action, identification, sampling, transport, preventive measures during handling Cholera, Influenza, Botulism, TB, hepatitis, SARS. Microbial infections and human behavior (Rabies, polio, Syphilis, AIDS,	09

	filariasis). Investigation of suspicious disease outbreak.	
Unit-IV	**Diagnosing and tracking microbial diseases** • Principles of epidemiology: epidemiology, public health, control of disease, Global health consideration, emerging and re-emerging infectious diseases. • Collection and preservation of microbial forensic samples, sampling for microbial forensic investigations, Preparedness. • Biosafety and biosecurity: Biosafety levels, Bio surveillance, documentation and case studies	**09**
Unit-V	**Laboratory Quality Management and Safety** • Laboratory quality management, Laboratory Accreditation, Validation of laboratory tests, Key Elements of a quality assurance and quality control (QA-QC) procedure manual, laboratory reports, records, security, Personnel and Training, Regulatory aspects. Quality Assurance Standards for Forensic DNA Testing Laboratories.	**09**

Suggested Readings/Reference Books:

1. Microbial Forensics : Roger G Breeze, Bruce Budowle, Steven E Schutzer
2. Microbial Forensics : Bruce Budowle, Steven E Schutzer, Roger G Breeze, Paul S Keim, Stephen A Morse
3. Chemical and Physical Signatures for Microbial Forensics: Cliff, J.B, Kreuzer, H.W, Ehrhardt C.J, Wunschel,D.S
4. Practical Approaches to Method Validation and Essential Instrument Qualification: Chung Chow Chan , Herman Lam , Xue-Ming Zhang.
5. Guidelines for Forensic Science Laboratories International Laboratory Accreditation Cooperation(ILAC)
6. DNA Technology in Forensic Science By Committee on DNA Technology in Forensic Science, National Research Council
7. The laboratory Quality Assurance system: A manual of Quality Procedures and forms. Thomas A Ratliff. 2003 3rd ed. John Wiley & Sons ISBN. 0-471 26918-2Systematic Quality Management Gary B Clark. 1995 Practical Laboratory Management Series.
8. Quality assessment of chemical Measurements John K. Taylor. CRC Press 1987. 087371-097-5.
9. Quality in the analytical chemistry laboratory E. Prichard. 1995 JohnWiley ISBN 0471955418
10. Juran's Quality Control Handbook, Fourth Edition, J.M. Juran, Frank M. Gryna, McGraw-Hill
11. International Editions, Industrial Engineering Series (1988)
12. Total Quality Control Essentials - Key Elements Methodologies and Managing for Success,

13. Quality Control & Application, Bertrand L. Hansen, Prabhakar M. Ghare, Prentice-Hall of India Pvt. Ltd., New Delhi-110001 (1993)

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FOR/MJ/652DT	Spectroscopy	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of spectroscopy and its application in forensic science

Course Objectives

The course has the following objectives:

- Students will gain an idea of atomic spectroscopy
- Students will learn the concepts of vibrational spectroscopy
- Students will have an understanding of mass spectrometry
- Students will understand the concepts of NMR spectroscopy
- Students will learn the concepts of X-ray spectroscopy

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to spectroscopy
- CO2: Apply vibrational spectroscopic techniques for the analysis of samples
- CO3: Analyze samples through mass spectrometer
- CO4: Compare processes and mechanism of various spectroscopic techniques
- CO5: Analyze the samples using X-ray and NMR spectroscopy

Unit	Course Content	Contact Hours
Unit-I	**Atomic Spectroscopy** • Atomic Absorption Spectroscopy: Principle, theory, instrumentation, sample introduction, nebulizers and burners system, non-flame methods of atomization, radiation sources, monochromators, detectors, interferences encountered, qualitative and quantitative analysis; Forensic significance of AAS. • Inductively Coupled Plasma – Optical Emission Spectroscopy: Principle, theory, instrumentation, inductively coupled and other methods of generating plasma, sample introduction, the axial and radial configuration of plasma source, monochromators, detectors, interferences encountered, qualitative and quantitative analysis using ICP-OES. The interface of ICP with MS and applications of ICP-MS in forensic science	09
Unit-II	**Vibrational Spectroscopy** • Infrared Spectroscopy: Principle, theory, the concept of dipole moment, types of IR active vibrations, Instrumentation, IR sources, dispersive and Fourier	09

	Transform IR spectroscopy, samplings techniques, IR detectors, working, Attenuated Total Reflectance FT-IR, Group frequencies for common organic functional groups, Systematic interpretation of IR spectrum, Applications and Limitations of IR Spectroscopy. • Raman Spectroscopy: Principle, theory, the concept of polarizability, types of Raman active vibrations, spectroscopic process, mutual exclusion principle, scattering of light, Stoke's, Rayleigh and Anti-Stoke's lines, Instrumentation, need of laser sources, dispersive and Fourier Transform Raman spectroscopy, detectors, working, Raman shift for common organic functional groups, interpretation of Raman spectrum, Applications and Limitations of Raman Spectroscopy.	
Unit-III	**Mass Spectrometry** • Introduction, Theory of Mass spectrometry, • Instrumentation, various hard and soft ionization methods, mass analyzers (magnetic sector, quadrupole filter, ion trap, time of flight, FT-ICR, etc.), mass detectors, • Basic mechanism of fragmentation and related rules, McLafferty Rearrangement, Nitrogen rule, Retro Diels Alder Reaction, fragmentation pathways for organic functional groups, Base Peak, Molecular Ions Peak • Interpretation of mass spectra of organic compounds, Forensic applications and Numerical problems based on mass spectrometry.	**09**
Unit-IV	**X-ray spectroscopy** • Introduction to X-rays, different types of X-ray sources, types of spectroscopic techniques using X-rays • X-ray fluorescence spectroscopy (XRF): Principle, theory, types of X-ray fluorescence spectroscopy (EDXRF and WDXRF), forensic applications of XRF • X-ray diffraction spectroscopy (XRD): Principle, theory, methods of X-ray diffraction spectroscopy (Laue, Rotating crystal and Powder XRD), forensic applications of XRD Fluorimetry and Phosphorimetry • Fluorimetry: Theory, Jablonski diagram, Concepts of singlet, doublet, and triplet electronic states, internal and external conversions, Basic differences in the measurement of fluorescence and phosphorescence, factors affecting fluorescence, quenching, and forensic applications.	**09**

Unit-V	**NMR Spectroscopy** • ^{1}H NMR spectroscopy: Introduction, theory, chemical shifts, factors influencing chemical shift, shielding and deshielding, spin-spin splitting, Coupling constant and factors influencing coupling constant, internal standard and NMR solvents, qualitative and quantitative analysis, Integration of signals, chemical shift scale. • ^{13}C NMR spectroscopy: Introduction, Problems in the integration of 13C NMR peaks, proton-coupled and proton decoupled 13C- spectra. Off resonance decoupling, DEPT techniques, • Structure elucidation using UV-VIS, FT-IR, 1H-NMR, 13C NMR, MS.	**09**

Suggested Readings/Reference Books:

1. D.A. Skoog, F.J. Holler and T.A. Neman, Harcoust; Principles of Instrumental Analysis: College publishers, Singapore
2. G.D. Christian and J.E. O'Reilly, Instrumental Analysis, Allyn and Bacon, Inc., Boston
3. F.W. Fifield and D. Kealey, Principles and practice of Analytical Chemistry, International Textbook Company, London.
4. R.P. Bauman, Absorption Spectroscopy, John Wiley, New York.
5. M. Donhrow, Instrumental Methods in Analytical Chemistry; Their Principles and practice; Vol.2, optical method, Pitaman, New York.
6. W.J. Price, Spectrochemical Analysis by Atomic Absorption, Hyden, London.
7. Analytical Chemistry by open Learning, John Wiley & Sons, New York

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FOR/MJ/652ET	Multimedia Forensics and Biometrics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers various aspects of multimedia forensics and forensic identification from image, video and audio through biometric traits.

Course Objectives

The course has the following objectives:

- Students will gain an idea of various aspects of multimedia forensics
- Students will learn and analyze image forgeries and their detection
- Students will have an understanding of video forensics
- Students will understand the concepts of audio forensics
- Students will learn the concepts of face and iris biometric identification

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Describe the various terms related to multimedia forensics
- CO2: Apply forensic attributes to detect image forgeries
- CO3: Analyze video for detection of tampering
- CO4: Compare various biometric attributes
- CO5: Analyze various audio files for detection of tampering

Unit	Course Content	Contact Hours
Unit-I	**Introduction to Multimedia Forensics** • Introduction and scope of Multimedia Forensics • Basics of Multimedia: image, video and audio, image, video and audio formats • Devices for capturing images and video: components of digital camera and photo sensors • Devices for capturing audio: microphone and its types • Standard and best practices in Multimedia Forensics	09
Unit-II	**Image Forensics** • Introduction and scope of image forensics • Active and passive image forensics, blind and non-blind image forensics • Source Identification: overview of image source identification, digital camera and image sensors, identification based on sensor defects and physical defects. • Authentication of image evidence: image tampering and its type, detection of image tampering based on scene, optics, sensor, processing and image property.	09

	• Steganography and digital watermarking: introduction and scope of steganography and digital watermarking, comparative study steganography and digital watermarking, basic concepts of steganography and digital watermarking models, basic concepts of digital watermarking security and steganalysis.	
Unit-III	**Video Forensics** • Video forensics: Introduction and scope • Extraction of frame and key-frame • Standards for video transmission • Methods of tampering with digital video including deepfakes • Forensic authentication of digital video • CCTV Forensics: Basics of CCTV, Data retrieval from CCTV/DVR, Enhancement of CCTV footage: best practices, Biometric identification from CCTV footage (face recognition), other measurements from CCTV footage (determination of height, speed of vehicle, vehicle identification number)	**09**
Unit-IV	**Audio Forensics** • Audio Forensics: Introduction and scope • Methods of tampering with digital audio • Forensic authentication of digital audio • Microphone Forensics • Enhancement of digital audio	**09**
Unit-V	**Face and Iris Biometrics** • Face Biometric system: Detection algorithm for facial images, Acquisition process for face biometric, features and feature extraction process for facial images, models for face recognition. • Iris Biometric system: structure and anatomy of iris, acquisition of iris images, segmentation of iris images, feature extraction process for iris biometric, Iris encoding and matching • Multimodal biometrics: introduction and scope of multimodal biometrics, acquisition process and fusion algorithms	**09**

Suggested Readings/Reference Books:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Prentice-Hall, Inc. Upper Saddle River, NJ, USA, 2006
2. Alan Bovik, Handbook of Image and Video Processing, Academic Press, USA, 2000
3. Husrev Taha Sencar and Nasir Memon, Digital Image Forensics: There is More to a

Picture than Meets the Eye, Springer Science and Business Media, New York, 2013
4. Anthony T.S. Ho and Shujun Li, Handbook of digital forensics of multimedia data and devices, John Wiley & Sons, Ltd., UK, 2015.
5. Hany Farid, Photo Forensics, The MIT Press, Cambridge, First Edition, 2016
6. Robert C. Maher, Principles of Forensic Audio Analysis, Springer, 2018
7. Biometrics by Anil Jain and Salil Prabhakar

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FOR/MJ/652P	Practical based on FOR/MJ/652T	Credit:01	Contact Hours:30	Marks:50

Course Overview

The practical course is based on the corresponding theory courses. The student needs to select one of the courses below:

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/MJ/652AP	Practical based on FOR/MJ/652AT	01	30	50
		OR			
2	FOR/MJ/652BP	Practical based on FOR/MJ/652BT	01	30	50
		OR			
3	FOR/MJ/652CP	Practical based on FOR/MJ/652CT	01	30	50
		OR			
4	FOR/MJ/652DP	Practical based on FOR/MJ/652DT	01	30	50
		OR			
5	FOR/MJ/652EP	Practical based on FOR/MJ/652ET	01	30	50

FOR/MJ/652AP	Practical based on FOR/MJ/652AT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Audio and Video Analysis** (FOR/MJ/652AT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Recording of speech samples using cassette and digital voice recorder
2. Collecting audio samples from different sources.
3. Auditory analysis of a given Speech Sample.
4. Open set and close set Comparisons of given Speech Samples
5. Spectrogram Analysis.
6. Collecting video evidences from different sources.
7. Image processing/enhancement.
8. Image Comparison and Image analysis.
9. Recognize and identify all the possible sources of video and digital evidence.
10. Speed analysis to determine the speed of moving objects.
11. Height analysis to determine the size of the objects.
12. Color analysis to correctly identify objects.
13. Time analysis to know the exact time of the incident.
14. Photographic Video Comparison.

15. Facial comparisons to identify humans in the video.
16. Vehicle identification to verify the identity of the vehicles
17. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/652BP	Practical based on FOR/MJ/652BT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Machine Learning and Multimedia Forensics** (FOR/MJ/652BT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To perform KNN classifier using Python
2. To perform ANN classifiers using Python
3. To perform SVM classifier using Python
4. To detect splicing in the given image/video frame
5. To perform steganalysis of the given stego image.
6. To read and write a given audio file in Python
7. To detect splicing in the given audio
8. To enhance a CCTV footage
9. To compare the face in the CCTV footage and the given photograph for identification
10. To identify registration number of a vehicle from a given CCTV footage
11. To compare the voice sample from the known and questioned audio recording
12. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/652CP	Practical based on FOR/MJ/652CT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Microbial Forensics** (FOR/MJ/652CT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Biochemical characterisation
2. Isolation techniques (pour plate, streak plate, spread plate)
3. Environmental microbiology: Isolation of coliforms
4. Enumeration of Soil microorganisms
5. Bacterial morphology and staining: Negative staining
6. Bacterial morphology and staining: Monochrome
7. Bacterial morphology and staining: Gram staining
8. Acid fast staining -ZNCF, Endospore - Schaeffer–Fulton
9. Environmental factors affecting growth of microorganisms, temperature, pH
10. Effect of disinfectants and antimicrobial agents
11. Environmental microbiology: Confirmation of coliforms on Endoagar or EMB agar
12. Isolation of microbiota from human/animal cadaver
13. Isolation and identification of Bacillus species
14. Isolation and characterization of microbial Plasmids for identification
15. DNA– Isolation from bacterial cell
16. Fungal toxin isolation/ Extraction
17. Visit autopsy centre at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Centre, Biodiversity and wildlife Centre.
18. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/652DP	Practical based on FOR/MJ/652DT	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Spectroscopy** (FOR/MJ/652DT). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Qualitative and quantitative analysis using UV-Visible spectrophotometer **(minimum four)**
2. Qualitative and quantitative analysis using AAS **(minimum two)**
3. Qualitative and quantitative analysis using ICP-OES
4. Qualitative and quantitative analysis using FTIR **(minimum four)**
5. Qualitative and quantitative analysis using Raman Spectrophotometer
6. Qualitative and quantitative analysis using XRF
7. Qualitative and quantitative analysis using XRD
8. Qualitative and quantitative analysis using XRD
9. Qualitative and quantitative analysis using GCMS
10. Qualitative and quantitative analysis using LCMS
11. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/MJ/652EP	Practical based on FOR/MJ/652ET	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Multimedia Forensics and Biometrics** (FOR/MJ/652ET). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To detect the tampering in images utilizing various characteristics
2. To link images with the source camera
3. To detect tampering in video utilizing various characteristics
4. To link video with the source camera
5. To retrieve data from CCTV/DVR
6. To enhance CCTV footage
7. To detect tampering in audio utilizing various characteristics
8. To link audio recordings with the source microphone
9. To identify the face in CCTV footage from the known faces
10. To determine height of a person from the given CCTV footage
11. To identify the vehicle identification number from the given CCTV footage
12. To determine speed of the vehicle from the given CCTV footage
13. To identify the questioned iris sample from the known iris samples
14. Any other practical designed by the faculty member based on recent advances/latest trends

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Discipline Specific Elective Courses

FOR/DSE/653T	Appliances and Equipment Failures	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of appliance and equipment failures

Course Objectives

The course has the following objectives:

- Students will gain an idea of appliance failure
- Students will learn motor failure
- Students will have an understanding of cable failure
- Students will learn the various aspects of machine failure

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to appliance and equipment failures
- CO2: Apply principles of physics in motor failure
- CO3: Analyze various cable failures
- CO4: Apply principle of physics in machine failure
- CO5: Analyze cataphoric vehicle defects

Unit	Course Content	Contact Hours
Unit-I	**Appliance failure** • Introduction, Kitchen and household appliances, HVAC systems, pumps, generators, motors, boilers, swimming pool failures, Dissolution of Aluminium, Welding failures	09
Unit-II	**Motor Failure-I** • Cars: torque converters, brake system overview, vacuum-assisted brake booster, brake line pressure control devices, step bore master cylinder, brake designs system and its failure,	09
Unit-III	**Motor Failure-II** • large vehicles, steering system, mechanism and its failure, Airbag system and its failure, Catastrophic vehicle defects	09

Unit-IV	**Cable failure** • Interpreting electrical activity: interpreting fire evidence, appearance of arced and fire-melted conductors, short circuits and ground fault arcs, arcing during fires, effects non-electrically caused melting by fire, alloying, misconceptions and cautions, undersized conductors, nicked or stretched conductors, deteriorated insulation, short circuit	**09**
Unit-V	**Machine failure** • Component fracture machines: load analysis on support bracket, analysis of crane failure, summing forces, gouge spacing-relative to vehicle motion and wheel lug distribution, broken pole analysis, telegraph, traction wires and cables with illustrative cases	**09**

Suggested Readings/Reference Books:

1. Forensic engineering fundamentals, Harold Franck, Darren Franck, CRC press Taylor and Francis group
2. Forensic science in crime investigation, 3rd edition, B.S. Nabar, Asia law house, Hyderabad
3. Sharma B.R.: Forensic science in criminal investigation and trials, central law agency, Alahabad (1974)
4. Kirck Paul L., Crime investigation, Inter-science, Publishers Inc., New York (1974)
5. Investigating material and component failure, written by TCR engineering services technical team, published July 2004
6. Considerations in forensic examination of automotive systems, CedomirDuboka, Int. J of Forensic Engg., 2012, Volume 1(2), 111-130.
7. Reliability and Failure of Electronic Materials and Devices, Book • 2nd Edition • 2011, Milton Ohring and Lucian Kasprzak, Imprint:Academic Press
8. Electronic Failure Analysis Handbook, by Perry Martin, Publisher: McGraw-Hill (February 28, 1999)
9. https://www.tasanet.com/Knowledge Center/Articles/ArtMID/477/ArticleID/146/Electrical-Equipment Failures-Cause-and-Liability
10. Machinery Failure Analysis Handbook - 1st Edition, Elsevier, Imprint: Gulf Publishing Company, Luiz Octavio AmaralAffonso
11. Preventing Thermal Cycling and Vibration Failures in Electronic Equipment, Dave S. Steinberg.

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FOR/DSE/653P	Practical based on FOR/DSE/653T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Appliances and Equipment Failures** (FOR/DSE/653T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Forensic Examination of HVAC systems.
2. Forensic Examination of fridge.
3. Forensic Examination of mixer.
4. Forensic Examination of cookers.
5. Forensic Examination of pumps.
6. Forensic Examination of generators.
7. Forensic Examination of motors.
8. Forensic Examination of boilers.
9. Forensic Examination of swimming pool failures.
10. Forensic Examination of Welding failures.
11. Forensic Examination f Dissolution of Aluminum
12. Study on forensic examination of electrical Cable failure.
13. Physical and microscopic studies of affected electric wires, panel boards due to electrical overload and short circuits
14. Forensic Examination of Power Failures.
15. Study on forensic examination of fractures on machines.
16. Study of load analysis on support bracket.
17. Study on forensic of analysis of crane failure.
18. Study on forensic of analysis of broken pole.
19. Study on forensic of analysis traction wires and cables failure.
20. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/654T	Web Application Penetration Testing	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of web application penetration testing

Course Objectives

The course has the following objectives:

- Students will gain an idea of working of web applications
- Students will learn and apply web authentication mechanism
- Students will have an understanding of concepts of various attacks through web
- Students will learn the concept of countermeasures taken in case of attacks through web

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to web applications
- CO2: Apply web authentication mechanism
- CO3: Analyze various attacks through web
- CO4: Compare various vulnerability of attacks
- CO5: Implement countermeasures in case of attacks

Unit	Course Content	Contact Hours
Unit-I	**Working of web application** • Working of Web Application, HTTP Request – Response, Fundamentals of Cookies, types of cookies, Sessions, SSL and TLS security, Web Application Proxies, Various techniques for Information Gathering, Fingerprinting Web Server, Use of OSINT, DNS lookup, whois, nslookup, subdomain enumeration, banner grabbing, shodan, google hacking database	09
Unit-II	**Web authentication mechanism** • Web Authentication Mechanism, Interception proxies – ZAP, Burpsuit, Metasploit for Web Application Attacks, Authentication and authorization bypass, Introduction to BeEF framework	09
Unit-III	**Attacks and countermeasures-I**	09

	• HTML Injection, SQL Injection, XSS Attack, Types of XSS, The Defence mechanism of SQL Injection and XSS attack, Broken authentication and session hijacking, Security misconfiguration, Session Hijacking, Malicious file inclusion, Directory traversal	
Unit-IV	**Attacks and countermeasures -II** • Insecure direct object reference, Information leakage and improper error handling, Failure to restrict URL access, Request forgery attack and countermeasures, Remote code execution, Vulnerability study	**09**
Unit-V	**Attacks and countermeasures -III** • RFI & LFI (remote file inclusion & local file inclusion) vulnerability, Denial of service (DOS) and distributed denial of service (DDOS) attacks, Countermeasures of DoS and DDoS, Cross Site Request Forgery, Exploiting Shellshock • Web platform security issues and countermeasures, Website code review and secure coding principles, Report writing	**09**

Suggested Readings/Reference Books:

1. Web Hacking 101
2. Preston Galla, How Personal and Internet Security Work,Que Publications
3. Alfred Basta and Wolf Halton, Computer Security Concepts, Issues and Implementation, Cengage Learning
4. Shon Harris, Allen Harper, Chris Eagle and Jonathan Ness, Gray Hat Hacking: The Ethical Hackers' Handbook, TMH Edition
5. Jon Erickson, Hacking: The Art of Exploitation, SPD
6. Peltier, T. R., Peltier, J., & Blackley, J. A. (2003). Managing a Network Vulnerability Assessment, CRC Press.
7. Caswell, B., Beale, J., Ramirez, G., & Rathaus, N. (2005). Nessus, Snort, and Ethereal Power Tools: Customizing Open Source Security Applications. Elsevier.

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FOR/DSE/654P	Practical based on FOR/DSE/654T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Web Application Penetration Testing** (FOR/DSE/654T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Installation of BWAPP, DVWA, webgoat for Web Pentesting
2. Information Gathering using various Online applications
3. Information gathering using Racon-ng
4. Performing Static Analysis using CMSMap, WPSCAN, DRUPSCAN, JOOMSCAN
5. Exploiting OS Command and HTML Injection
6. Exploiting SQL Injection, Manually and using SQLmap
7. Exploiting Cross-Site Scripting
8. Exploiting File upload vulnerability (LFI, RFI)
9. File upload vulnerability Exploitation
10. No rate limit using Burp suite
11. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/655T	Genetic Engineering	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of Genetic Engineering

Course Objectives

The course has the following objectives:

- Students will gain an idea of recombinant DNA technology
- Students will learn and apply electrophoretic and blotting techniques
- Students will have an understanding of nucleic acid extraction and labelling
- Students will learn the concept of sequencing methods

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to genetic engineering
- CO2: Apply electrophoretic techniques
- CO3: Analyze samples using blotting techniques
- CO4: Compare DNA libraries and reporting system
- CO5: Implement nucleic acid extraction and labelling

Unit	Course Content	Contact Hours
Unit-I	**Recombinant DNA Technology** • Recombinant DNA Technology overview. Vectors, Enzymes: Restriction endonucleases, ligases, Alkaline phosphatases, S1-nuclease & their applications. Transformation techniques, Screening of recombinant cells.	09
Unit-II	**Electrophoresis and blotting techniques** • Principle and working of Electrophoretic techniques –Agarose Gel Electrophoresis, Native and de-native Poly Acrylamide Gel electrophoresis, SDS-PAGE, 2-D gel electrophoresis, pulse-field gel electrophoresis, Iso-electric focusing. Blotting techniques: Southern, Northern & Western blotting.	09
Unit-III	**Nucleic acid extraction and labelling**	09

	• Nucleic acid extraction, detection, purification, measuring the concentration of DNA & RNA with UV, Nanodrop. • Labelling of Nucleic acids, radio-label and Non-radio label and detection of DNA. Chemical tagging with biotin & Digoxigenin, hybridization of DNA & RNA. • Thermal cycler: PCR, Inverse-PCR, Reverse Transcriptase-PCR, Nested-PCR, Real-time PCR, differential display PCR, RAPD, and RACE.	
Unit-IV	**Sequencing Methods** • Genomics & DNA sequencing: General Principle, primer walking, automated sequencing; Mapping of sequence tagged sites, shotgun sequencing, survey of human genome, sequence polymorphism: SSLP's & SNP's, gene identification by exon trapping.	**09**
Unit-V	**DNA libraries and Reporter System** • DNA libraries: gDNA, cDNA, Screening library by hybridization, screening of library by Immunological procedure, chromosome walking, expression. • Reporter system: luciferase, Green Fluorescent Protein, gene fusion. Transcriptome analysis, DNA microarrays for gene expression, serial analysis of gene expression (SAGE)	**09**

Suggested Readings/Reference Books:

1. Biophysical Chemistry Principles and techniques: Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath.
2. Instrumental Methods of Analysis6th Edition. (1986): H.H. Willard, L.L. Merritt Jr. and others.CBS Publishers and Distributors.
3. Instrumental Methods of Chemical Analysis. (1989): Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.
4. A Biologists Guide to Principles and Techniques of Practical Biochemistry. (1975): Williams, B.L. and Wilson, K.

5. Spectroscopy. (Vol. 1): Edited by B.B. Straughan and S. Walker. Chapman and HallLtd.
6. Gel Electrophoresis of Proteins- A Practical Approach: Hanes.
7. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
8. Analytical Biochemistry: Holme.
9. Introduction to High Performance Liquid Chromatography: R. J. Hamilton and P. A.Sewell.
10. Spectroscopy: B.P. Straughan and S. Walker.
11. Practical aspects of Gas Chromatography and Mass Spectrometry (1984) by Gordon M.Message, John Wiley and Sons, New York.
12. Gel Chromatography by Tibor Kremmery.
13. Principles and Techniques of Biochemistry and Molecular Biology: Edt. Keith Wilson, John Walker

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FOR/DSE/655P	Practical based on FOR/DSE/655T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Genetic Engineering** (FOR/DSE/655T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Blood examination for diseases
2. Estimation of haemoglobin percentage
3. Microscopic study of abnormal RBCs
4. To determine blood group from stains of blood and various body fluids with Absorption inhibition, mixed agglutination, and absorption-elution techniques.
5. Determination of secretor and non-secretor status
6. To perform a precipitin test for species of origin determination.
7. Rocket immunoelectrophoretic
8. Microscopic study of sperm and its abnormality using a compound microscope
9. Sperm counting by haemocytometer
10. Western blotting analysis
11. Detection of semen
12. WIDAL Test
13. VDRL
14. Spot Elisa
15. Ouchterlony Double diffusion
16. Cross Over Electrophoresis
17. Examination of bloodstains: physical and chemical tests; spectroscopic examination.
18. Examination of seminal stains: crystal tests, chemical, biochemical, Microscopical and electro-immuno-diffusion test.
19. Examination of saliva and its stains: microscopical and chemical tests.
20. Faecal stains: Physical, chemical and microscopical examination, testing of urine and sweat
21. Visit autopsy centre at mortuary, Forensic Science Laboratory, Pathology Laboratory, Veterinary Centre, Biodiversity and wildlife Centre.
22. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/656T	Physical Chemistry	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of physical chemistry

Course Objectives

The course has the following objectives:

- Students will gain an idea of ionic equilibria and biological reactions
- Students will learn and apply principles of thermodynamics
- Students will have an understanding of electrochemistry
- Students will learn the rate laws and complex reactions

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to physical chemistry
- CO2: Apply principles of thermodynamics
- CO3: Analyze various concepts of electrochemistry
- CO4: Compare various characteristics of complex reactions
- CO5: Implement molecular reaction dynamics

Unit	Course Content	Contact Hours
Unit-I	**Ionic Equilibria and Biological Reactions** • Exact treatment of the dissociations of weak acids and bases, dissociation constant of polyprotic acid, statistical effects in polyprotic acid, dissociations constant of complex ions, Logarithmic expression for pH and pOH, calculation involving buffer solutions, buffer capacity and buffer index, salt effect, solubility product and its applications	09
Unit-II	**Thermodynamics** • State function, path function, exact differential and inexact differential, internal energy and enthalpy, temperature dependent internal energy and enthalpy, reversible and irreversible adiabatic expansion. The entropy of irreversible changes, the Helmholtz and Gibbs function, Entropy and entropy change in an	09

	ideal gas with temperature and pressure, Clausius inequality, chemical potential, chemical potential of a substance in a mixture • Thermodynamics of biochemical reactions, binding of oxygen by myoglobin and haemoglobin, reaction between microscopic and macroscopic dissociation constant	
Unit-III	**Eletrochemistry** • Debye-Huckel theory of strong electrolytes, Debye-Huckel-Onsager equation Testing of the equation, Debye-Falkenhagen effect, Wein effect, activity coefficient, mean ionic activity coefficient; Debye-Huckel limiting law ionic strength. Electrocapillary phenomena, and its measurements. Effect of anions, cations and molecules on electrocapillary curves. Electrocapillary properties of mercury-solution interface. • Polarography: the Ilkovic equation and its derivation, concentration polarization, instrumentation, advantages of DME, half wave potential. Applications of polarography, numerical.	**09**
Unit-IV	**Rate laws and Kinetics of complex reactions** • Recapitulations of basic concept, the temperature dependent reaction rates, reaction moving towards equilibrium, consecutive reaction, parallel reactions, pre-equilibria, unimolecular reactions • Fast reactions: flash photolysis, flow technique, stopped flow technique, relaxation method, the steady state approximation, chain reactions - free radical polymerization reaction between H_2 and Br_2, explosive reaction	**09**

Unit-V	**Molecular Reaction Dynamics and Enzyme Catalysis** • Collision theory of bimolecular gas phase reactions, diffusion-controlled and activation-controlled reaction in solution, activated complex theory of reaction rate, Eyrings equation • Michaelis mechanism, effect of pH and temperature on enzyme catalyzed reactions, limiting rate, Lineweaver Burk and Eadie equation and plots, inhibition of enzyme action, competitive inhibition and non-competitive inhibition	09

Suggested Readings/Reference Books:

1. Physical Chemistry by P.W.Atkin and De Paul
2. Physical Chemistry by T.Engel and P. Reid
3. Physical Chemistry and molecular approach by D. Mequarie and J. Siman
4. Physical Chemistry for biological sciences by Raymond Chang (Universal books, 2000)
5. Physical Chemistry by Merron and C.F. Prouton
6. Physical Chemistry by G.M. Barrow

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FOR/DSE/656P	Practical based on FOR/DSE/656T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Physical Chemistry** (FOR/DSE/656T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Determination of the strength of halide in a mixture potentiometrically
2. Determination of dissociation constants of phosphoric acid potentiometrically
3. Determination of dissociation constants of weak acid potentiometrically
4. Determination of acid and basic dissociation constants of an amino acid and its isoelectric point
5. Determination of the strength of strong and weak acid in a given mixture conductometrically
6. Determination of solubility and solubility product of sparingly soluble salt $BaSO_4$
7. Determination of equilibrium quotient for the formation of monothiocynato iron (III) complex
8. Determination of pK1 and pK2 value of phosphoric acid by pH metry
9. Determination of rate constant of reaction between Potassium Persulphate and Potassium Iodide having equal/unequal concentration of the reacting species
10. Determination of solubility of benzoic acid in water at different temperature and hence its heat of solution
11. To study auto catalysis reaction between potassium permanganate and oxalic acid
12. Determination of formula of the complex formed between Cu (II) and ammonia by distribution method
13. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/657T	Forensic Speaker Identification	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of forensic speaker identification

Course Objectives

The course has the following objectives:

- Students will gain an idea of basic concepts of acoustics
- Students will learn and apply forensic linguistics in voice identification
- Students will have an understanding of theory of voice production
- Students will learn various approaches for forensic voice comparison

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to forensic speaker identification
- CO2: Apply forensic linguistics in speaker identification
- CO3: Analyze theory of speech production
- CO4: Compare attributes of voice of various speakers
- CO5: Implement techniques for speaker identification

Unit	Course Content	Contact Hours
Unit-I	**Fundamentals of acoustics** • Pure tone, particle and pressure wave movement in sound, essential constituents of sound, interference patterns • Complex tone, Harmonics: Characteristics of Periodic Complex Tones, Aperiodic Complex Signals • Frequency and pitch, pitch of complex tone, intensity and loudness, velocity of sound in space • Resonance, resonance in an organ pipe/air column	09
Unit-II	**Forensic Linguistics** • Introduction to linguistics and subfields, historical perspective, phonetic transcription, International Phonetic alphabets (IPA), IPA for English, Hindi and Marathi	09
Unit-III	**Theory of voice production**	09

	• Linguistic perspective: speech, language and thought, development of language and speech, model of thought, language and speech • Neurological perspective: nervous system, role of CNS in speaking, role of PNS in speaking Phonetics Perspective: respiration: breathing mechanism, quiet and speech breathing, phonation: physics behind vibration of vocal folds and articulation: articulatory gesture, articulation of vowel and consonants	
Unit-IV	**Acoustic theory of speech** • Acoustics of vowel: formants, source and filter theory, shape of vocal tract in various vowel sound production, spectrogram of vowels • Acoustics of consonants: resonance of consonants, effect of context • Acoustics of prosody: suprasegmental features	**09**
Unit-V	**Approaches to forensic voice comparison** • Auditory: critical listening and observation of linguistics cues; Spectrographic: auditory spectrographic approach and voiceprint matching; Acoustic-phonetic: Quantitative measures of acoustic cues; Automatic: feature extraction: MFCC and spectral features, modelling of features and classification • Software and hardware available for forensic voice comparison • Standard guidelines for voice matching, collection of voice samples and probability scale of opinion • Milestone cases and legal framework for forensic speaker identification	**09**

Suggested Readings/Reference Books:

1. Voice Identification: Theory and Legal Applications, Oscar Tosi, University Park Press, Baltimore, USA, 1979.
2. A Course in Phonetics, Sixth Edition, Peter Ladefoged and Keith Johnson, Wardsworth Cengage Learning, Boston, USA, 2011.
3. Forensic Speaker Identification, Philip Rose, CRC Press, USA, 2003.
4. Speech Acoustics and Phonetics, Gunar Fant, Springer Publishers, USA, 2004.
5. Speech Science Primer: Physiology, Acoustics, and Perception of Speech, Lawrence J. Raphael, Gloria J. Borden, Katherine S. Harris, Lippincott Williams & Wilkins, 2007.
6. Fundamentals of Speech Science, Donald J. Fucci and Norman J. Lass, Allyn and Bacon, 1997.

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FOR/DSE/657P	Practical based on FOR/DSE/657T	Credit:01	Contact Hours:30	Marks:50

Course Overview

This is a laboratory course based on **Forensic Speaker Identification** (FOR/DSE/657T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. To record speech sample of a subject
2. To represent speech signal in the form of waveform and to resample the same
3. To convert analog speech signal into digital one
4. To segregate voice sample of a particular subject
5. To form clue words of given speech sample of a subject
6. To describe speech sample in terms of IPA
7. To perform auditory analysis on a given set of speakers
8. To study formant frequency in a given sound spectrograph
9. To study pitch and intonation pattern in a given sound spectrograph
10. To study LPC in a given sound spectrograph
11. To apply automatic techniques to identify a speaker
12. To perform language-independent speaker identification
13. Any other practical designed by the faculty member based on recent advances/latest trends

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FOR/DSE/658T	Forensic Psychology and Legal Framework	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the various aspects of forensic psychology and legal framework including criminal justice system and investigation process in India

Course Objectives

The course has the following objectives:

- Students will gain an idea of investigative interviewing
- Students will learn and apply psychological profiling methods
- Students will have an understanding of offender profiling and criminal behavior analysis
- Students will learn criminal justice system and investigative techniques in India

Course Outcomes

After the completion of the course, the students will be able to do the following:

- CO1: Define and explain various terms related to investigative interviewing
- CO2: Apply various psychological profiling methods
- CO3: Analyze various aspects of criminal behavior
- CO4: Compare profiles of various offender type
- CO5: Analyze criminal justice system and investigation process in India

Unit	Course Content	Contact Hours
Unit-I	**Investigative Interviewing** • Importance of Investigative Interviewing, Influence of Psychological factors in investigative interview • Psycho-physical basis of assessment- nature, physical and psychological processes • P.E.A.C.E Model of Interviewing • Cognitive Interviewing • Ethical Interviewing • Other Interview Techniques	**09**
Unit-II	**Review of Psychological Profiling method** • Polygraph (Lie Detector), • Brain Electrical Oscillation Signature Profiling (BEOS), • Narco-analysis • Voice-Stress Analysis/ Layered Voice Analysis	**09**

Unit-III	**Offender Profiling and Criminal Behavior Analysis** • History: Serial Killers, Signature (Modus Operandi) • Crime Scene Analysis, Psychological Autopsy, Behavior Profiling • Nature of Crime- Organized, Disorganized, Planned, Spontaneous. • Stages and Types of Offender Profiling • Psychometric Assessment tools used in Forensic Psychology • Assessment of Offenders • Rehabilitation & Correctional Treatment of Offenders • Techniques, Strategies and Types of Treatment	**09**
Unit-IV	**Indian Criminal Justice System** • Inquisitorial and Accusatorial Criminal Justice System: Meaning and differences. Autrefois Acquit and Autrefois convict: Constitutional and Statutory provisions, Important wings of the criminal justice system: Its structure, functions and authority, Constitution of Criminal Courts and their hierarchy, the role of Prosecution and defense, Functions and Powers of Police, Correctional Institutions: Prisons, Borstal Homes and Special Homes.	**09**
Unit-V	**Investigation Proceedings in India** • Police Investigation: Initiation of investigation proceedings- FIR, arrest, confession of the accused and statements of the witnesses, witness protection, search and seizures. Reforms in Criminal Justice System- Justice Malimath Committee Recommendations, Cr. P.C amendment in 2005.	**09**

	• Reforms as proposed in Bharatiya Nagarik Suraksha Sanhita Bill	

Suggested Readings/Reference Books:

1. Introduction to Forensic Psychology by Bruce Arrigo
2. Forensic & Criminal Psychology by Dennis Howitt.
3. Abnormal Psychology by Halgin and Whitbourne.
4. Abnormal Psychology by Robert C. Carson, James N. Butcher, Susan Mineka, Jill M. Hooley thirteenth Edition, Thirteenth Edition.
5. Encyclopedia of Forensic Science by Jay A. Siegel, PekkaJ. Saukko, Geoffey C. Knupfer, Volume-1 to Volume-5.
6. Teisi Thou (2011) Forensic Psychology, New Delhi: ABD Publisher
7. Peter Joyce and Wandy Laverick, Criminology: A Complete Introduction, 2020
8. Ram Ahuja, Criminology, Rawat Publications, 2000
9. Bare act on Bharatiya Nagarik Suraksha Sanhita Bill, 2024

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FOR/DSE/658P	**Practical based on FOR/DSE/658T**	**Credit:01**	**Contact Hours:30**	**Marks:50**

Course Overview

This is a laboratory course based on **Forensic Psychology and Legal Framework** (FOR/DSE/658T). The course objectives and outcomes of this laboratory course have been added to the theory course. A minimum of 10 practical has to be covered in the semester for successful completion of the course.

List of Practical

(Minimum of 10 practical has to be performed for successful completion of the course)

1. Uniform Child Custody Evaluation System
2. Minnesota Multiphasic Personality Inventory-2/A (MMPI2/A)
3. Mobile Phone Addiction Scale
4. Mental Status Examination
5. Taking Case History
6. Coping Responses Inventory for Adult/Children
7. Alienation Scale
8. Rorschach Inkblot Test
9. Miller Forensic Assessment of Symptoms Test
10. Case Study of Crime Based on Mental/Personality Disorder
11. Polygraphy of a subject
12. Any other practical designed by the faculty member based on recent advances/latest trends

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Research Project

FOR/RP/699	Research Project-II	Credit:06	Contact Hours:180	Marks:100

Course Overview

The students based on their interests can select a research project in the following domains. At the end of the semester, students have to submit a complete research project based on their findings.

SN	Code	Name of the course	Credit	Contact Hours	Marks
1	FOR/RP/699A	Research project in Forensic Physics -II	06	180	100
		OR			
2	FOR/RP/699B	Research project in Digital Forensics-II	06	180	100
		OR			
3	FOR/RP/699C	Research project in Forensic Biology-II	06	180	100
		OR			
4	FOR/RP/699D	Research project in Forensic Chemistry-II	06	180	100
		OR			
5	FOR/RP/699E	Research project in Question Document, Fingerprint, and Biometrics-II	06	180	100

FOR/RP/699A	Research project in Forensic Physics -II	Credit:06	Contact Hours:180	Marks:100

Course Overview

This student needs to select a research topic in Forensic Physics. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/699B	Research project in Digital Forensics-II	Credit:06	Contact Hours:180	Marks:100

Course Overview

This student needs to select a research topic in Digital Forensics. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be

approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/699C	Research project in Forensic Biology-II	Credit:06	Contact Hours:180	Marks:100

Course Overview

This student needs to select a research topic in Forensic Biology. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/699D	Research project in Forensic Chemistry-II	Credit:06	Contact Hours:180	Marks:100

Course Overview

This student needs to select a research topic in Forensic Chemistry. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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FOR/RP/699D	Research project in Questioned Document, Fingerprint, and Biometrics - II	Credit:06	Contact Hours:180	Marks:100

Course Overview

This student needs to select a research topic in Forensic Questioned Document, Fingerprint, and Biometrics. At the start of each semester, the student will work under a mentor and prepare a research proposal. The proposal will be approved by the affiliated college. At the end of the semester, the student will submit a research project report. The report should follow the same structure and formatting rules as of thesis.

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