Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

NAAC Reaccredited with 'A' Grade

Faculty of Science and Technology

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

Subject: Forensic Science

Course Structure and Curriculum for University Department
(Outcome-Based Credit System)

As per National Education Policy 2020
(Effective from Academic Year -2023-24)

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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.

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 Science from a recognized university with 45% marks will be eligible for getting admission to the first year of PG programs.. 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 the 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 minimum of 75 % attendance in each theory and practical courses for appearing in the Semester End Examination (SEE), otherwise he / she will not be strictly allowed for appearing for the SEE. However, students having 65 % attendance may request Head of the concerned Institution for the condonation of attendance on medical ground.

Assessment Scheme/Scheme of Examination

The assessment scheme is as follows:

- Each course has been assigned marks equivalent to 25 marks/credit. Thus, each theory course is 75/100 marks while the practical/Laboratory course is 25/50 marks.

Moreover, research project shall be 100/150 while On-Job-Training shall be 100 marks.

- 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. Two tests on completion of 40%, and 100% syllabus, each of 20 marks will be conducted and the average result will be reported. Presentation of 10 marks and assignments of 10 marks will also be conducted to get an aggregate of 40% weightage.
- Changes in examination scheme is possible as per the guidelines issued by the university from time to time.

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	FOS/MJ/500T	Introduction to Forensic Science	3	-	3	-	**14**
	FOS/MJ/501T	Forensic Physical Sciences	3		3	-	
	FOS/MJ/502T	Instrumental Methods in Forensics	3	-	3	-	
	FOS/MJ/500P	Practical based on FOS/MJ/500T	-	2	-	1	
	FOS/MJ/501P	Practical based on FOS/MJ/501T	-	2	-	1	
	FOS/MJ/502P	Practical based on FOS/MJ/502T	-	2	-	1	
	FOS/MJ/503P	Skill/Practical based activity	-	4	-	2	
DSE (Choose anyone from the five courses: Theory and Practical together makes a complete course)	FOS/DSE/504T	Mathematical Physics	3	-	3	-	**4**
	FOS/DSE/504P	Practical based on FOS/MJ/504T	-	2	-	1	
	FOS/DSE/505T	Python Programming	3	-	3	-	
	FOS/DSE/505P	Practical based on FOS/MJ/505T	-	2	-	1	
	FOS/DSE/506T	Biochemistry	3	-	3	-	
	FOS/DSE/506P	Practical based on FOS/MJ/506T	-	2	-	1	
	FOS/DSE/507T	Inorganic Chemistry	3	-	3	-	
	FOS/DSE/507P	Practical based on FOS/MJ/507T	-	2	-	1	
	FOS/DSE/508T	Insurance Forensics-I	3	-	3	-	
	FOS/DSE/508P	Practical based on FOS/MJ/508T	-	2	-	1	
RM	FOS/RM/509	Research Methodology and Statistics	4	-	4	-	**4**
			16	**12**	**16**	**06**	**22**

Major Mandatory (DSC)

- FOS/MJ/500T- Introduction to Forensic Science
- FOS/MJ/500P-Practical based on FOR/MJ/500T
- FOS/MJ/501T- Forensic Physical Sciences
- FOS/MJ/501P-Practical based on FOS/MJ/501T
- FOS/MJ/502T- Instrumental Methods in Forensics
- FOS/MJ/502P-Practical based on FOS/MJ/502T

Discipline Specific Elective (DSE): (Choose any one from Pool /Basket)

- FOS/DSE/504T-Mathematical Physics
- FOS/DSE/504P-Practical based on FOS/DSE/504T

OR

- FOS/DSE/505T-Python Programming
- FOS/DSE/505P-Practical based on FOS/DSE/505T

OR

- FOS/DSE/506T-Biochemistry
- FOS/DSE/506P-Practical based on FOS/DSE/506T

OR

- FOS/DSE/507T- Inorganic Chemistry
- FOS/DSE/507P-Practical based on FOS/DSE/507T

OR

- FOS/DSE/508T-Insurance Forensics-I
- FOS/DSE/508P-Practical based on FOS/DSE/508T

Research Methodology (RM)

- FOS/RM/509- Research Methodology and Statistics

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	FOS/MJ/550T	Forensic Chemical Sciences	3	-	3	-	**14**
	FOS/MJ/551T	Forensic Biological Sciences	3	-	3	-	
	FOS/MJ/552T	Forensic Digital and Multimedia Sciences	3	-	3	-	
	FOS/MJ/550P	Practical based on FOS/MJ/550T	-	2	-	1	
	FOS/MJ/551P	Practical based on FOS/MJ/551T	-	2	-	1	
	FOS/MJ/552P	Practical based on FOS/MJ/552T	-	2	-	1	
	FOS/MJ/553	Skill/Practical based activity	-	4	-	2	
DSE (Choose anyone from the five courses: Theory and Practical together makes a complete course)	FOS/DSE/554T	Material Science and Forensic Engineering	3	-	3	-	**4**
	FOS/DSE/554P	Practical based on FOS/MJ/554T	-	2	-	1	
	FOS/DSE/555T	File Systems	3	-	3	-	
	FOS/DSE/555P	Practical based on FOS/MJ/555T	-	2	-	1	
	FOS/DSE/556T	Genetics and Bioinformatics	3	-	3	-	
	FOS/DSE/556P	Practical based on FOS/MJ/556T	-	2	-	1	
	FOS/DSE/557T	Organic Chemistry	3	-	3	-	
	FOS/DSE/557P	Practical based on FOS/MJ/557T	-	2	-	1	
	FOS/DSE/558T	Insurance Forensics-II	3	-	3	-	
	FOS/DSE/558P	Practical based on FOS/MJ/558T	-	2	-	1	
OJT/FP	FOS/OJT/599	OJT/FP	-	8	-	4	**4**
			12	**20**	**12**	**10**	**22**

Major Mandatory (DSC)

- FOS/MJ/550T- Forensic Chemical Sciences
- FOS/MJ/550P-Practical based on FOS/MJ/550T
- FOS/MJ/551T- Forensic Biological Sciences
- FOS/MJ/551P-Practical based on FOS/MJ/551T

- FOS/MJ/552T- Forensic Digital and Multimedia Sciences
- FOS/MJ/552P-Practical based on FOS/MJ/552T

Discipline Specific Elective (DSE): (Choose any one from Pool /Basket)

- FOS/DSE/554T-Material Science and Forensic Engineering
- FOS/DSE/554P-Practical based on FOS/DSE/554T

OR

- FOS/DSE/555T-File Systems
- FOS/DSE/555P-Practical based on FOS/DSE/555T

OR

- FOS/DSE/556T-Genetics and Bioinformatics
- FOS/DSE/556P-Practical based on FOS/DSE/556T

OR

- FOS/DSE/557T- Organic Chemistry
- FOS/DSE/557P-Practical based on FOS/DSE/557T

OR

- FOS/DSE/558T-Insurance Forensics-II
- FOS/DSE/558P-Practical based on FOS/DSE/558T

On-Job-Training/Field Project (OJT/FP)

- FOS/OJT/599- On-Job-Training/Internship/Field Project

Detailed Curriculum of Semester-I

Discipline-Specific Core Courses

FOS/MJ/500T	Introduction to Forensic Science	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers basic concepts of forensic science, various physical evidence and 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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FOC/MJ/500P	Practical based on FOC/MJ/500T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Introduction to Forensic Science (FOS/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 blood stain pattern
15. Any other practical designed by the faculty member based on recent advances/latest trends

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FOS/MJ/501T	Forensic Physical Sciences	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 Fingerprint 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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FOS/MJ/501P	Practical based on FOS/MJ/501T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Forensic Physical Sciences (FOS/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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FOS/MJ/502T	Instrumental Methods in Forensics	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers the instrumental methods used in forensic examination. It is covering 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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FOS/MJ/502P	Practical based on FOS/MJ/502T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Instrumental methods in Forensics (FOS/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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FOS/MJ/503P	Skill/Practical-Based Activity	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.

List of activities

Forensic Physics and Ballistics

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

OR

Forensic Chemistry and Toxicology

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

OR

Forensic Biology, Serology and DNA Fingerprinting

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

OR

Digital and Cyber Forensics and IT Security

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

OR

Questioned Documents, Fingerprints, and Biometrics

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

Discipline Specific Elective Courses

FOS/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 surfaces of solids of revolution. Double and Triple integrals.	**09**

	• **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, Determining time since death, Determining age from bone or tooth material.	**09**

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. Toroni, 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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FOS/DSE/504P	**Practical based on FOS/DSE/504T**	**Credit:01**	**Contact Hours:30**	**Marks:25**

Course Overview

This is a laboratory course based on Mathematical Physics (FOS/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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FOS/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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FOS/DSE/505P	Practical based on FOS/DSE/505T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Python Programming (FOS/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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FOS/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, gluconeogenesis, glucuronic acid pathway. Metabolic	**09**

	sources of acetyl CoA. Regulation and amphibolic nature of the cycle. Glyoxylate cycle.	
Unit-III	**Protein and Nucleotide Metabolism-I** • Transamination, deamination, Fate of amino acid skeleton, urea cycle, precursors for compounds other than proteins, Salvage and de-novo pathways of purine and pyrimidine nucleotide biosynthesis	**09**
Unit-IV	**Protein and Nucleotide Metabolism-II** • 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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FOS/DSE/506P	Practical based on FOS/DSE/506T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Biochemistry (FOS/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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FOS/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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FOS/DSE/507P	Practical based on FOS/DSE/507T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Inorganic Chemistry (FOS/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. $Cis\text{-}K[Cr(C_2O_4)_2(H_2O)_2]$
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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FOS/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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FOS/DSE/508P	Practical based on FOS/DSE/507T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Insurance Forensics-I (FOS/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

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

Course Overview

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

Course Objectives

The course has the following objectives:

- To make the students aware the concepts of research
- To facilitate the students to make 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**	**12**

	• 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.	
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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Detailed Curriculum of Semester-II

Discipline-Specific Core Courses

FOS/MJ/550T	Forensic Chemical Sciences	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** • Introduction to drug of abuse; drug dependence, drug addiction	**09**

	• 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 • Breath analyzer: Principle, mechanism, types of breath analyser, blood-alcohol sample collection and preservation	**09**

	• **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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FOS/MJ/550P	Practical based on FOS/MJ/550T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Forensic Chemical Sciences (FOS/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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FOS/MJ/551T	Forensic Biological Sciences	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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FOS/MJ/551P	Practical based on FOS/MJ/551T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Forensic Biological Sciences (FOS/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. 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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FOS/MJ/552T	Forensic Digital and Multimedia Sciences	Credit:03	Contact Hours:45	Marks:75

Course Overview

The course covers basic concepts of 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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FOS/MJ/552P	Practical based on FOS/MJ/552T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Forensic Digital and Multimedia Sciences (FOS/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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FOS/MJ/553P	Skill/Practical-Based Activity	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.

List of activities

Forensic Physics and Ballistics

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

OR

Forensic Chemistry and Toxicology

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

OR

Forensic Biology, Serology and DNA Fingerprinting

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

OR

Digital and Cyber Forensics and IT Security

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

OR

Questioned Documents, Fingerprints, and Biometrics

- Examine various insurance fraud
- Any other problem identified by the students

Discipline-Specific Elective Courses

FOS/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 is covering topics on Forensic Engineering and its applications in solving real crime scenario.

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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FOS/DSE/554P	Practical based on FOS/DSE/554T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Material Science and Forensic Engineering (FOS/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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FOS/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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FOS/DSE/555P	Practical based on FOS/DSE/555T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on File System (FOS/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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FOS/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, genotypes, phenotypes, multiple alleles, genetic variants), Mitosis, meiosis, sex chromosomes, sex linkage, nondisjunction of X chromosomes, genotypic sex determination, genic sex determination, 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,	**09**

	genome organization, chromatin remodelling; types of histones, histone modifications-methylation, 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, 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), mutagens, induced mutagenesis (UV, nitrosoguanidine, ethyl methane sulfonate) mutation rate and genetic load. Disorders: Metabolic disorders: introduction and examples (Amino acid metabolism - Phenylketonuria, Carbohydrate metabolism: lactose intolerance, genetic disorders (Haemophilia, thalassemia, sickle cell anaemia, Down's syndrome, Turners syndrome), Molecular Basis and detection of inherited disease, gene mapping and genetic risk assessment; Repair mechanisms (Photoreactivation, Base excision, Mismatch, Nucleotide excision, SOS repair)	**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	**09**

	Mitochondrial and genomic DNA), Preparation of genomic library, Submission of sequence in library, 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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FOS/DSE/556P	**Practical based on FOS/DSE/556T**	**Credit:01**	**Contact Hours:30**	**Marks:25**

Course Overview

This is a laboratory course based on Genetics and Bioinformatics (FOS/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 wild animals 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. Any other practical designed by the faculty member based on recent advances/latest trends

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FOS/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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FOS/DSE/557P	**Practical based on FOS/DSE/557T**	**Credit:01**	**Contact Hours:30**	**Marks:25**

Course Overview

This is a laboratory course based on Organic Chemistry (FOS/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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FOS/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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FOS/DSE/558P	Practical based on FOS/DSE/558T	Credit:01	Contact Hours:30	Marks:25

Course Overview

This is a laboratory course based on Insurance Forensics-II (FOS/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

FOS/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) and 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.