



**CHRIST**  
(DEEMED TO BE UNIVERSITY)  
B E N G A L U R U • I N D I A

**Department of Life Sciences**

**Syllabus**

**Master of Science in Forensic Science**

**2021-22**

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Christ (Deemed To Be University)

Bengaluru 560029, Karnataka, India

[www.christuniversity.in](http://www.christuniversity.in)

**Department Overview:**

The Department of Life Sciences aims at developing talented individuals for the prosperity of the society. The curriculum is designed in such a way that the students are able to apply the knowledge into practice. The aim of the department is to provide an on hand training of practical knowledge to meet the demands of the industry and to prepare students for higher studies and research. The interactive method of teaching is to bring about attitudinal changes to future professionals of the industry.

Equal importance is also given to practical and theoretical methods of learning apart from experiential and digital modes of learning. Projects form an integral part of the curriculum. Apart from the syllabus, the regular syllabus, the department offers Certificate Courses in gardening and herbal medicine, industry visit, field trips and visits to places of important biodiversity reserves.

**Vision and Mission Statement:**

**The department seeks to offer its students holistic development and academic excellence to contribute effectively to the research and development of the subject.**

**Programme objectives**

- Make students familiar with the field of forensic science which includes investigating a crime by applying forensic science principles.
- Enhance knowledge, in depth understanding and application of forensic science, policing and criminal investigation by teaching and research.
- Develop critical and analytical subject specific skills involving the principles, practices and techniques of specific field.
- Develop competence in research methods and presentation of information.
- Develop skills in forensic identification, forensic problem solving either independently or as a team member.
- Keep abreast with all recent developments and emerging trends in Forensic science, Ethics and the law.

**Programme Specific Outcomes (PSOs):**

- PSO 1. Understand application of Forensic Science, Photography and Crime Scene Management
- PSO 2. Techniques of Forensic Physics, Forensic Ballistics, Forensic Chemistry and Toxicology
- PSO 3. Study Forensic Dermatoglyphics and other impressions. All PSOs are helpful in forensic identification with reference to various crimes.

**PROGRAMME STRUCTURE (M. Sc. Biotechnology)**

<b>SEM</b>	<b>Course Code</b>	<b>TITLE</b>	<b>No of Hrs/ week</b>	<b>Marks</b>	<b>Credit</b>
<b>I</b>	MFS 131	Forensic Science, Photography, Crime Scene Management	4	100	4
	MFS 132	Criminology, Criminal Law and Police Administration	4	100	4
	MFS 133	Analytical Instruments & Techniques	4	100	4
	MFS 134	Fundamentals of Questioned Document Examination	4	100	4
	MFS 151	Practical I: Pattern Evidence at Scene of Crime, Forensic Photography and Forensic Document Examination	6	100	3
	MFS 152	Practical II: Analytical Instruments & Techniques	6	50	3
	MFS 135	Research Methodology in Forensic Sciences	2	50	2
<b>II</b>	MFS 231	Forensic Biology and Forensic Medicine	4	100	4
	MFS 232	Forensic Chemistry and Toxicology	4	100	4
	MFS 233	Forensic Ballistics and Forensic Physics	4	100	4
	MFS 234	Information Security and Cyber Crime	4	100	4
	MFS 251	Practical III: Forensic Biology, Forensic Chemistry, and Toxicology	6	100	3
	MFS 252	Practical IV: Forensic Ballistics, Forensic Physics and Information Security	6	100	3
	MFS 235	Essential of Mathematics and Statistics in Forensic Science	3	100	3
<b>III</b>	MFS 331	Forensic Anthropology	4	100	4
	MFS 332	Forensic Dermatoglyphics and other impressions	4	100	4
	MFS 333	Forensic Genetics & Forensic Serology	4	100	4
	MFS 334	Forensic DNA Profiling & Bioinformatics	4	100	4

	MFS 351	Practical V: Forensic Anthropology	4	100	2
	MFS 352	Practical VI: Forensic Serology, DNA profiling and Bioinformatics	8	100	4
	MSF 335	Fundamentals of Forensic Psychology	3	100	3
	MSF 381	Summer Internship		50	2
IV	MFS 441	Forensic Drugs Analysis	4	100	4
		Analytical Forensic Toxicology	4	100	4
		Practical VII: Forensic Drugs Analysis and Analytical Forensic Toxicology	4	50	2
	MFS 442	Forensic Biology and Wildlife Forensics	4	100	4
		Theoretical and Practical Aspects of Biological Evidences	4	100	4
		Practical VII: Forensic Biology and Wildlife Forensics and Theoretical and Practical Aspects of Biological Evidences	4	50	2
	MFS 481	Dissertation		150	16

Total Credits: 95

**Semester I****MFS 131 Forensic Science, Photography, Crime Scene Management****Core Course****Credits: 4****Total Hours: 60****Course objective****Course Objectives:**

The objective of this course is to introduce the concept of forensic science, its development and progress over time. It will also familiarize students with the organizational setting and working set up of forensic laboratories. It aims to introduce different techniques used in forensic investigations with the principles involved. The course would apprise students with the basics of forensic photography techniques with management of crime scene in different situations.

**Contents:****Unit 1*****Forensic Science Unit***

Introduction, Need, Scope, Concepts and Significance of Forensic Science, History and Development of Forensic Science, Laws and Basic principles of Forensic Science, Branches of forensic science, Organizational set-up of a Forensic Science Laboratory. Investigative strategies. Expert testimony and eye-witness report.

**Unit 2*****Tools and techniques in Forensic Science***

Basic principles of microscopy, spectroscopy, chromatography. Electrophoresis, Enzyme-Linked Immunosorbent Assay (ELISA), Radio Immuno Assay (RIA). Measuring and optical instruments. Research methodologies. Formation of research design on a specific problem. Central tendency and Dispersion. Test of significance. Analysis of variance. Correlation and Regression.

**Unit 3*****Forensic Photography***

Basic principles of Photography, Techniques of black & white and color photography, cameras, lenses, shutters, depth of field, film; exposing, development and printing techniques; Different kinds of developers and fixers; UV, IR, fluorescence illumination guided photography; Modern development in photography- digital photography, working and basic principles of digital photography; Surveillance photography. Videography and Crime Scene & laboratory photography.

**Unit 4*****Crime Scene Management***

Crime scene investigations, protecting and isolating the crime scene; Documentation, sketching, field notes and photography. Searching, handling and collection, preservation and transportation of physical evidences. Chain of custody and Reconstruction of scene of crime. Report writing.

**Course Learning Outcomes:**

CO 1 Understand the basic concept, meaning, significance and development of Forensic science.

CO 2 To elucidate research methodologies and techniques used in the formation of research design on a specific problem.

CO 3 Describe Crime scene investigations, Reconstruction of scene of crime, basic principles of photography and its relevance.

**Suggested Readings:**

1. Houck, M.M & Siegel, J.A; Fundamentals of Forensic Science, Academic Press, London, 2006.
2. Sharma, B.R; Forensic Science in Criminal Investigation & Trials, Universal Publishing Co., New Delhi, 2003
3. Nanda B.B and Tewari, R.K; Forensic Science in India- A vision for the Twenty First Century, Select Publisher, New Delhi, 2001.
4. James, S.H and Nordby, J.J; Forensic Science- An Introduction to Scientific and Investigative Techniques, CRC Press, USA, 2003.
5. Saferstein; Criminalistics- An Introduction of Forensic Science, Prentice Hall Inc, USA, 2007.
6. Barry, A.J. Fisher; Techniques of Crime Scene Investigation, 7th Ed, CRC Press, New York, 2003.
7. Mordby, J. & Reckoning, D; The Art of Forensic Detection, CRC Press New York, 2003.
8. G.R. Chatwal; Analytical Spectroscopy 2nd Edn, Himalaya Publishing House New Delhi, 2002.
9. Aitken and Stoney; The Use of Statistics in Forensic Science, Ellis Horwood, New York, 1991.
10. Robertson and Vignaux; Interpreting Evidence, John Wiley, New York, 1995.
11. H.L. Blitzer and J.Jacobia; Forensic Digital Imaging and Photography, Academic Press, London, 2002
12. David R.Redsicker; The Practical Methodology of Forensic Photography- 2nd Ed. CRC Press, New York, 2001.
13. R.E.Jacobson, S.F.Ray, G.G.Attridge; The Manual of Photography- Photographic and Digital Imaging , N.R. Oxford

**MFS 132 Criminology, Criminal Law and Police Administration Core Course**

**Credits: 4**

**Total Hours: 60**

**Course Objectives:**

The objective of this course is to introduce the concept and scope of crime. It will familiarize students with types of crime and its effects as well its prevention. The course would highlight about criminal behavior and related theories. The course aims to discuss the concept of Juvenile delinquency and Victimology. It will disseminate information to students with specific criminal Law, Indian Penal Code: sections, Criminal Procedure Code and police Administration.

**Unit 1*****Crime***

Definition, concept and scope of crime. Types of crime. Causes, effects, control and prevention of crime. Recent developments.

**Unit 2*****Criminology and criminal anthropology***

Aim and scope of criminology; Criminal behavior and theories of criminal behavior: classic, positivist, sociological. Organized crimes, white collar crime. Juvenile delinquency. Role of correctional institutions. Criminal profiling and modus operandi, portrait parley, voice stress analysis. Victimology.

**Unit 3*****Criminal Law***

Indian Penal Code: sections-23, 24, 25, 39, 44, 52, 76-79, 84-86.

Criminal Procedure Code: sections-2, 6-35, 41-60, 61-90, 154-176, 293, 294. Charges: bailable/non-bailable offences, cognizable/non-cognizable, summon case and warrant cases.

Indian Evidence Act: sections- 3, 24-30, 45, 135-138, 141. Expert testimony.

NDPS Act, Food and Adulteration Act, Drugs and Cosmetic Act, Arms Act, Explosives Act.

**Unit 4*****Police Administration***

History and development of police administration; Police duties, responsibilities and powers. Organization and structure of police station; maintenance of crime records and accountability of police to law. People and society. Custodial deaths, Police and Human Rights.

**Course Learning Outcome**

CO 1 To understand concept of crime and recent development in its control and prevention.

CO 2 To study the aim and scope of criminology.

CO 3 to elucidate Criminal profiling and modus operandi, portrait parley, voice stress analysis

CO 4 To describe History and development of police administration; Police duties, responsibilities and powers.

**Suggested Readings**

1. Swanson, C.R, Terrles, L & Taylor, R.W; Police Administration, Prentice Hall, USA, 1998.
2. Gross, H; Criminal Investigation- A Practical Textbook for Magistrates, Police Officers, and Lawyers; Universal Law Publishing Co., New Delhi, 2000.
3. Lyman, M.D; Criminal Investigation – The Art & the Science, Prentice Hall, New Jersey, 2002.
4. O'Hara CE & Osterburg, JW; An Introduction to Criminalistics., Indiana University. Press, London, 1972.
5. Swanson, C.R, Chamelin, N.C, & Territ, L; Criminal Investigator, McGrawhill, New York, 2000.
6. The Indian Evidence Act, (1872), Amendment Act (2002); Universal Law Publishing Co., 2003.
7. The Code of Criminal Procedure (1973) Amendment Act, (2001); Universal Law Publishing Co., 2002.
8. Rattan Lal & Dhiraj Lal; The Indian Penal Code, 28th Ed. Wadhwa & Co. Nagpur, 2002.

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**MFS 133 Analytical Instruments & Techniques Core Course****Credits: 4****Total Hours: 60****Course objective****Course Objectives:**

The objective of this course is to introduce specialized techniques and their application in forensic science. The students will be able to understand the atomic & molecular spectroscopy, physical instrumentation techniques, radiochemical and nuclear techniques, biological and biochemical techniques with their general principles involved as well as their applied aspects.

**Unit-I Microscopy Techniques**

Microscope, Compound Microscope, Polarized Light Microscopy, Fluorescence Microscopy, Comparison Microscope, Stereo-zoom Microscope. Transmission Electron Microscope, Video-zoom Microscope. Scanning Electron Microscope – Energy Dispersive X-Ray. Atomic Force Microscope.

**Unit II*****Atomic & Molecular Spectroscopy***

Spectroscopy, electromagnetic spectrum, sources of radiation, their utility and limitations. Conventional sources for UV, visible and infrared rays, sources for shorter wavelength radiations (X-ray tubes), radioactivity, Laser (He, Ne Argon, ion, dye lasers, semiconductor lasers) a source of radiation, interaction of radiation with matter:- reflection, absorption, transmission, fluorescence, phosphorescence and their forensic applications, radiation filters. Detection of radiations; photographic detectors, thermal detectors, photoelectric detectors etc. Atomic spectra, energy levels, quantum numbers and designation of states, selection rules, qualitative discussions of atomic spectra. Elements of X-ray spectrometry, fluorescence, energy dispersive X-ray analysis (EDX), wavelength dispersive X-ray analysis (WDX), X-ray diffraction, Auger effect. Application of these techniques in forensic science.

**Unit III*****Physical instrumentation techniques***

IR spectroscopy- correlation of infrared spectra with molecular structure, Fourier transform, infrared (FTIR) and Raman spectroscopy, fluorescence and phosphorescence spectrophotometry, Ultra violet and visible spectrophotometry: Types of sources, filters-cells and sampling devices, detectors, resolution, qualitative and quantitative methods for detection.

Fluorescence and phosphorescence spectrometry: Types of sources, structural factors, instrumentation, comparison of luminescence and UV-visible absorption methods. Atomic absorption spectrometry: Instrumentation and techniques, interference in AAS, background correction methods, quantitative analysis. Atomic emission spectrometry: Instrumentation and techniques, arc/spark emission, ICP-AES, comparison ICP vs AAS methods, quantitative analysis, applications. Techniques -RBS (Rutherford Back Scattering spectrometry) Application of these techniques in forensic science.



**Unit IV*****Radiochemical and Nuclear techniques***

Radiochemical techniques: Basic principles and theory, introduction about nuclear reactions and radiations, neutron sources, neutron activation analysis (NAA), Thermal analysis methods: Basic principles and theory, differential scanning calorimetry and differential analysis, thermogravimetry. Nuclear Magnetic Resonance spectroscopy: Basic principles, theory and instrum, Mass Spectrometry, GCMS, LCMS, Secondary Mass Spectrometry, Laser Mass spectrometry, Fast Atom bombardment and liquid secondary Ion Mass spectrometry, High performance liquid chromatography, Electrospray Ionization mass spectrometry. Application of these techniques in forensic science.

**Unit V*****Biochemical techniques***

Biological and biochemical techniques: General principles of Biological/ Bio-chemical Analysis, pH and buffers, Physiological solution, cell and tissue culture, Cell fractionation, Biological variations etc. Centrifugation Techniques, Immuno-chemical Technique, General principles, Production of antibodies, Precipitin reaction, Gel immune-diffusion, Immunoelectrophoresis, complement fixation, Radio Immuno Assay (RIA), Enzyme-linked ImmunoSorbent Assay (ELISA), Fluorescence immune assay. Chromatographic Techniques, Electrophoretic Technique: General principles, Factors affecting electrophoresis, Low voltage thin sheet electrophoresis, High voltage electrophoresis, Sodium dodecylsulphate (SDS) polyacrylamide gel electrophoresis, Isoelectric focusing (IEF), Isoelectrophoresis, Preparative electrophoresis, Horizontal and Vertical Electrophoresis. Application of these techniques in forensic science.

**Course Learning Outcome**

CO 1 To know about the concept of Spectroscopy, electromagnetic spectrum, sources of radiation, their utility and limitations.

CO 2 This paper tends to describe the different Physical instrumentation techniques.

CO 3 To understand basic principles and theory of radiochemical techniques.

CO 4 To highlight general principles of biological and biochemical techniques.

**Suggested Readings**

1. Robinson, J.W; Atomic Spectroscopy, 2nd Ed. Revised & Expanded, Marcel Dekkar, Inc, New York, 1996.
2. Workman, J; Art Springsteen; Applied Spectroscopy- A compact reference for Practitioners, Academic Press, London, 1997.
3. Subrahmanyam, N. & Lal B; A text Book of Optics, S. Chand & Company, New Delhi, 2004.
4. Willard, H.H. Lynne L. Merrett, J. Dean, A. Frank, A. Settle. J; Instrumental Methods of Analysis, 7th Edn. CBS pub. & Distributors, New Delhi, 1986.
5. Khandpur, R.S; Handbook of Analytical Instruments, Tata McGraw Hill Pub. Co. New Delhi, 2004.
6. Thomson, K.C. & Renolds, R.J; Atomic Absorption Fluorescence & Flame Emission Spectroscopy, A Practical Approach, 2nd Edn. Charles Griffith & Company, New South Wales, 1978.
7. Dudley, H. Williams & Fleming, I; Spectroscopic Methods in Organic Chemistry, 4th Edn, Tata McGraw- Hill Publishing Company, New Delhi, 1994.

**MFS 134 Fundamentals of Questioned Document Examination****Core Course****Credits: 4****Total Hours: 60****Course Objective**

The objective of this course is to disseminate the knowledge about various types of forensic documents including genuine, forged and holographic documents. It also aims to discuss the principles of handwriting, its identification, tools needed for forensic document examination & their use in forensic science. The course will explain the typewritten, printed documents and forgery detection techniques to students

**Unit 1*****Introduction to Document Examination***

Nature and problems of document examination, classification of forensic documents, Specimen/Admitted writings/type writings etc: handling, preservation and marking of documents, importance of natural variations and disguise in writing, various types of forensic documents- genuine and forged documents, holographic documents, principles of handwriting identification, basic tools needed for Forensic Document Examination & their use, analysis of paper and inks.

**Unit 2*****Handwriting and Signature examination***

Various writing features and their estimation, general characteristics of handwriting, individual characteristics of handwriting, ethnic and gender variability of handwriting, various types of forgeries and their detection, examination of signatures – characteristics of genuine and forged signatures, identification of forger, identification of writer of anonymous letters and application of Forensic Stylistics/Linguistics in the identification of writer, examination of built-up documents and determination of sequence of strokes.

**Unit 3*****Typewritten and Printed Documents***

Identification of typescripts-identification of typist, various types of printing processes, identification of printed matter including printing of security documents and currency notes, identification of electronic typewriters, dot matrix, inkjet and laser jet printers, examination of black and white and color photocopies, fax messages and carbon copies.

**Unit 4*****Forgery Detection***

Determination of age of documents by examination of signatures, paper, ink etc., Examination of alterations, erasures, over writings, additions and obliterations, decipherment of secret writings, indentations & charred documents, physical matching of documents, examination of seal, rubber and other mechanical impressions, examination of counterfeit currency notes, Indian passport/visas, stamp papers, postal stamps etc., examination of fake credit cards, e documents, digital signatures, an introduction of computer forensics, preliminary examination of documents, opinion writings and reasons for opinion.

**Course Learning Outcome**

CO 1 The paper tends to introduce students to document examination. Also describes classification, variation, nature and problems of document examination.

CO 2 To learn writing features, their estimation, general characteristics, individual characteristics, ethnic and gender variability of handwriting, various types of forgeries and their detection.

CO 3 To identify typescripts, various types of printing processes and their examination.

CO 4 To Determine identification of age of documents by examination of signatures, paper, ink etc.

**Suggested reading:**

1. Hilton, O; Scientific Examination of Questioned Documents. Revised Edition, Elsevier, New York, 1982.
2. Osborn, A.S; Questioned Documents, 2nd Ed., Universal Law Publications, Delhi, 1998.
3. Osborn, A.S; The Problem of Proof, 2nd Ed., Universal Law Pub. Delhi, 1998.
4. Thomas, C.C; Identification System for Questioned Documents, Billy Prior Bates Springfield, Illinois, USA, 1971.
5. Harrison, W.R; Suspect Documents Their Scientific Examination, Universal Law Publication, Delhi, 2001.
6. Morris, R.N; Forensic Handwriting Identification, Academy Press, London, 2001.
7. Sheila, K; Graphotypes a new Plant on Handwriting Analysis, Crown Pub. Inc., USA, 1983.
8. Lerinson, J; Questioned Documents, Academy Press, London, 2001.
9. Katherine, M. K; CDE-Forensic Document Examination-Humana Press, New Jersey, 2007.

### **MSF135: RESEARCH METHODOLOGY IN FORENSIC L SCIENCES**

#### **Core Course**

**Credits: 2**

**Total Hours: 30**

#### **Course Objective**

1. To understand the theoretical basis of conducting research
2. To design a research
3. Understanding the importance of research paper
4. To impart knowledge regarding the ethics in research

#### **Learning Outcome**

By the end of this course, students will be able to

- find gaps in the existing research of their interest and conduct the research accordingly
- to write a research proposal.
- publish research and review articles in the journal with impact factor.
- write a project report as well as research paper.

#### **Unit I. Concepts of Research and Research Formulation**

**(10 hrs)**

Need for research, stages of research; Basic concepts of research -Meaning, Objectives, Motivation and Approaches. Types of Research (Descriptive/Analytical, Applied/Fundamental, Quantitative/Qualitative, Conceptual/ Empirical); Research formulation - Observation and Facts, Prediction and explanation, Induction, Deduction; Defining and

formulating the research problem, Selecting the problem and necessity of defining the problem; Literature review -Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review; Hypothesis -Null and alternate hypothesis and testing of hypothesis -Theory, Principle, Law and Canon.

**Unit II. Research Designs****(7 hrs)**

Research Design -Basic principles, Meaning, Need and features of good design, Important concepts; Types of research designs; Development of a research plan -Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs; Data collection techniques, Case-Control Studies, Cohort Studies.

**Unit III. Scientific Documentation and Communication****(4hrs)**

Workbook maintenance, Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications); Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

**Unit IV. Information Science, Extension and Ethics****(9hrs).**

Sources of Information -Primary and secondary sources; Library - books, Journals: Indexing journals, abstracting journals, research journals, review journals, e-journals. Impact factor of journals, NCBI-Pub Med.; periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents. Internet -Search engines and software, Online libraries, e-Books, e-Encyclopedia, TED Talk, Institutional Websites; Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, plagiarism, Geographical indications; Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards; Extension: Lab to Field, Extension communication, Extension tools; Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.

**Essential Reading**

1. Thomas, C.G., Research Methodology and Scientific Writing. Anne Books Pvt. Ltd. Bengaluru. 2017.
2. Dawson, C. Practical research methods. UBS Publishers, New Delhi. 2002.

**Recommended Readings**

3. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong, 1995.

4. Ruzin, S.E. Plant micro technique and microscopy. Oxford University Press, New York, U.S.A., 1999.

**MFS 151 Practical I: Pattern Evidence at Scene of Crime, Forensic Photography and Forensic Document Examination**

**Credits: 3**

**Lectures: 90 Hrs**

**Core Course**

**Practical: Pattern Evidence at Scene of Crime and Forensic Photography**

1. Descriptive study of organizational structure of a forensic science laboratory.
2. To carry out photography of indoor and outdoor crime scenes
3. Crime scene photographic processing and development in different light sources and using different filters.
4. To carry out digital photography of various forensic evidences
5. Mock crime scene investigation and writing a report on evaluation of crime scene.
6. Interpretation of crime scene notes, photos, sketches and reconstruction of crime scene
7. Microscopy of various physical evidences
8. Study the theories of crime
9. Criminal profiling
10. Portrait parley
11. Expert testimony in a mock court case scenario.

**Practical: Forensic Document Examination**

1. Identification of Handwriting Individual Characteristics.
2. Study of natural variations and fundamental divergences in handwriting.
3. Comparison of handwritings.
4. Detection of Simulated forgery.
5. Detection of traced forgery.
6. Study of Disguise in handwriting.
7. Comparison of Typewritten scripts
8. Currency note examination

**MFS 152 Practical II: Analytical Instruments & Techniques****Credits: 3****Lectures: 90 Hrs****Core Course****Practical**

1. Preparation of the Normal, Molar and Standard & buffer solutions.
2. Determine the density of alcohol by using pyknometer.
3. Determination of pH of a solution using pH meter.
4. Comparison of soil samples using microscopic and density-gradient distribution of particles method.
5. Microscopic examination of hair and fibres.
6. Examination of documents under stereo zoom microscope, UV rays, IR rays and oblique light.
7. To separate the dyes and inks/plant pigments/body fluids/explosives by thin layer chromatography.
8. Care, handling, preservation, marking, packing and forwarding of documents.
9. Laboratory equipment-handling of Stereo microscope, Stereo zoom Microscope, comparison microscope, Raman spectrophotometer.
10. Use of Vernier Callipers for internal & external diameter, Screw Gauge for thickness, Spherometers for curvature of surface and Laser device for accurate Distance Measurements.
11. Determination of GSM and thickness of papers.
12. Use of breath analyzer for measuring blood alcohol concentration.

**Semester II****MFS 231 Forensic Biology and Forensic Medicine****Core Course****Credits: 4****Total Hours: 60****Unit I**

Identification of blood stains: Presumptive tests- Benzidine test, Phenolphthalein test, Leucomalachite test, Tetra-Methylbenzidine test and O-Tolidine, Luminol test. Confirmatory tests- Haemochromogen test, Haematin test and Haemin test.

Identification of seminal stains- Presumptive Tests-Acid Phosphatase Test, Barberios Test and Florence Crystal Test. Confirmatory Test -Sperm Detection.

Identification of saliva stains: Starch iodine test, Radial gel diffusion and examination of buccal epithelial cells.

Identification of Urine stains: Physical examination, Odor Test, Urea nitrate crystal test and creatinine test.

Identification of vomit stains: Detection of Mucus, Free HCL and Endothelial cells.

Identification of faecal stains: Microscopic detection of undigested food particles, vegetables material and muscle fibers, Urobilinogen Test.

Diatoms and Pollen grains- their identification and Forensic Significance. Microorganism in biological warfare.

**Unit II**

Human Body – External Morphology. Introduction to adult human skeleton. Terminology associated with skeletal direction, gross morphology of long bones and human dentition. Bite marks- Forensic significance.

Hair structure. Hair growth. Phases of growth and growth rate. Hair characteristics from various body parts. Sex, age and race from hair. Forensic examination and comparison of hair.

Human vs. animal hair. Forensic significance of hair. Types of vegetable fibers and their identification.

**Unit III**

Thanatology- Stages of death. Suspended animation. The moment of death. Modes of death. Signs of death and changes following death. Estimation of PM Interval. Entomological evidence and their collection.

Microorganism responsible for food poisoning. Collection, preservation and forwarding of samples – vomit, stool, stomach wash and residual food.

**Unit IV**

Injuries –Classification and Medico-legal Aspects. Mechanical Injuries. Firearm Injuries. Thermal Injuries. Explosion Injuries. Electrical Injuries. Atmospheric Lightning. Radiation Injury. Regional Injuries. Traffic Accidents.

**Reference Books:**

1. Houck, M.M. & Siegel, JA; “Fundamentals of Forensic Science”, Academic Press, London, 2006.

2. Sharma, B.R.; “Forensic Science in Criminal Investigation & Trials”, Universal Publishing Co., New Delhi, 2003.



3. Barry, A.J. Fisher; "Techniques of Crime Scene Investigation", 7th Ed, CRC Press, NY, 2003.
4. Eckett, WG & James, SH; "Interpretation of Blood Stains Evidence of Crime Scene", Elsevier Pub. NY, 1989.
5. Chadha, PV; "Handbook of Forensic Medicine & Toxicology", Jaypee Brothers, New Delhi, 2004.
6. O'Hara CE and Osterburg, JW; "An Introduction to Criminalistics", Indiana Univ. Press, London, 1972.
7. James SH; "Scientific and Legal Applications of Blood Stain Pattern Identification", CRC Press, 1998.
8. Smith, BC, Holland MM, Sweel, DL & Dizzino, A; "DNA & Forensic Odontology- Manual of Forensic Odontology", Colorado Springs, USA, 1995.
9. Biology Method Manual, Metropolitan Police Forensic Science Laboratory, London, 1978
10. Catts, EP & Haskell NH; "Entomology and Death- A Procedural Guide", Joyce's Print shop, 1990.
11. Working Procedure Manual – DNA, BPR&D Pub, 2000.
12. Kirbylorne T; "DNA Fingerprinting - An Introduction", WH Freeman & Co., NY, 1990.
13. Hillson, S; "Dental Anthropology", Cambridge University Press, UK, 1996

## Semester-II

### MFS 232 Forensic Chemistry & Toxicology

#### Unit I - Forensic Chemistry

Scope & significance of Forensic Chemistry, Types of cases/exhibits received for analysis.

Trap Cases: Collection, and Preliminary analysis of evidence in trap cases.

Alcoholic Beverages: Types of alcohols, country made liquor, illicit liquor, denatured spirits, Indian made foreign alcoholic and non-alcoholic beverages.

Dyes: Scope & Significance of dyes in crime investigation, analysis of ink by TLC and UV visible spectrophotometry.

Petroleum products and their adulterations: Chemical composition of various fractions of Petroleum Products, Analysis of petrol, kerosene, diesel.

#### Unit II- Forensic Toxicology

Forensic Toxicology - Scope and Significance. Classification of Poisons based on their mode of action, uses and origin. Poisons - Types, routes of administration, toxicity, sign and symptoms. Factors affecting the effect of poison, medico-legal aspects of poisoning cases.

Common Poisoning in India: Pesticides: Different types and their formulations, identification of pesticides, standard or sub-standard or substituted pesticides.

Guidelines for collecting forensic evidences in poisoning cases at crime scene. Importance of Post mortem examination in poisoning cases. Sample preparation for the analysis of poisons in body tissues/fluids and analysis by various instrumental techniques.

#### Unit III- Narcotic Drugs and Psychotropic Substances

Scope and significance NDPS drugs in forensic science, NDPS Act, Classification and characterization of NDPS drugs, Drug Law Enforcement, Search & Seizure, Sampling procedure, Forwarding of sample to FSL, Sample preparation for analysis, Preliminary analysis of drugs, Reporting of drug cases, Drug abuse, Drug addiction and its problems.

#### **Unit IV – Fire/Arson and Explosives**

Fire: Introduction to Fire & Arson, origin of fire, Chemistry of Fire, Firefighting operations, preservation of fire scene, collection of evidences, Seat of fire, cause of fire, motives, Analysis of fire debris, Case studies related to fire and Arson.

Explosive and Explosion: Scope & significance of explosive analysis in forensic science, Types of explosives, deflagration and detonation, explosive trains, collection, preservation and forwarding of exhibits, preliminary analysis of explosives. Do's and Don'ts. Case studies related to explosives.

#### **Reference Books:**

1. Finar I.L; "Organic Chemistry: Vol. I Fundamental Principle", Pearson Education, Singapore, 1967.
2. Pearson D; "Chemical Analysis of Food", Chemical Publ. Co. New York, 1971.
3. Morrison R.T and Boyd R. N.; "Organic Chemistry", 6th Edition, Prentice Hall, 2003.
4. "Laboratory Procedure Manual: Petroleum Products", Directorate of Forensic Science, MHA, Govt. of India, 2005.
5. "Working Procedure Manual on Chemistry", Directorate of Forensic Science MHA Govt. of India, 2005.
6. Bureau of Indian Standard Specifications related to Alcohols and Petroleum Products.
7. Welcher Frank; "Standard Methods of Chemical Analysis", 6th Edition, Van Nostrand Reinhold, 1969.
8. Watson C.A; "Official and Standardized Methods of Analysis", Royal Society of Chemistry, UK, 1994.
9. "Laboratory Procedure Manual: Forensic Toxicology", Directorate of Forensic Science, MHA, Govt. of India, 2005.
10. Narayanan, T.V; "Modern Techniques of Bomb Detection and Disposal", R. A. Security system, 1995.
11. Jacqueline Akhavan; "The chemistry of explosives", Royal Society of Chemistry, UK, 1998.
12. "Working Procedure Manual- Chemistry, Explosives and Narcotics", BPR&D, 2000.
13. Niesink, RJM; "Toxicology- Principles and Applications", CRC Press, 1996.
14. Chadha, PV; "Handbook of Forensic Medicine & Toxicology", Jaypee Brothers, New Delhi, 2004.
15. Modi, JP; "Textbook of Medical Jurisprudence & Toxicology", N.M. Tripathi Pub, 2001.

**Semester-II**  
**MFS 233 Forensic Ballistics & Forensic Physics**

**Unit I**

History and development of firearms – their classification and characteristics, various components of small arms, smooth bore and rifled firearms, bore and caliber, shotgun barrels, chokes - their degrees and types; different automatic mechanisms used in small arms – blow back, recoil operated and gas operated mechanisms, rifling, class characteristics of rifled bore, purpose of rifling, methods to produce rifling; trigger and firing mechanism, trigger pull, accidental discharge of firearms, country-made firearms, improvised and imitation firearms. 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.

Safety aspects about handling of firearms and ammunition.

**Unit II**

Physical evidence available in crime involving firearms, handling of physical evidence at crime scene, principles and practice of identification of firearms, class and individual characteristics, various marks on fired cartridge cases and bullets, test firings, techniques of obtaining test materials, comparison microscope and matching of marks on evidence and test exhibits, automated bullet-cartridge identification system – IBIS and NIBIN.

Estimation of range of firing: burning, blackening, tattooing, spread of pellets, Walker's test. Chemical tests of copper and lead around gunshot holes.

Gun-Shot Residue: Dermal nitrate test, why was it abandoned, mechanism of formation of gunshot residue, various methods of lifting of gunshot residue, detection of GSR by AAS.

Gun-Shot Injuries – caused by shotguns, rifles, revolvers, pistols, evaluation of gunshot injuries.

Knowledge of Arms Act.

**Unit – III**

Criminalistics and Forensic Engineering: Role of trace evidence analysis and source correspondence, Arson Investigation, Introduction to Nano-science

Advanced Physical Techniques: Introduction to Lasers, Advanced microscopy & 3D scanning; Introduction to Atomic Absorption & Emission Spectroscopy, Fourier transform and X-ray spectroscopy

Collision Investigation and Reconstruction: Causes and Prevention of Road Accidents, Liability to accidents, Communication on the road, Reconstruction and proactive measures.

**Unit – IV**

Forensic Voice Identification: Resonance and overtones, synthesis of complex waves, Place Theory of Hearing, Anatomy of Vocal Tract, Vocal Formants, analysis and recording of voice samples in trap/sting investigation

Photography and Forensic Image analysis: Light and Illumination, Optics and Lenses, Zoom and close-up Photography, Introduction to forensic use of digital images, resolution, colour space, file formats, photo sensors, memory and media, computing images

Forensic Video Analysis: Introduction to video, Video Cameras, Video images, Video Captures, CCTVs, Retrieval of images and their evidence analysis

**Reference Books:**

1. Sharma, B.R.; "Firearms in Criminal Investigation & Trials", Universal Law Publishing Co Pvt Ltd, New Delhi, 4th Edition, 2011.
2. Hatcher, Jury and Weller; "Firearms Investigation, Identification and Evidence", Stackpole Books, Harrisburg, Pa, 1997.
3. Heard, B.J; "Handbook of Firearms and Ballistics", John Wiley, England, 1997.
4. Jauhari M; "Identification of Firearms, Ammunition, & Firearms Injuries", BPR&D, New Delhi.
5. Hogg, I.V; "The Cartridge guide – A Smallarms Ammunition Identification Manual", The Stackpole publishing Co., Harrisburg, Pa, 1982.
6. Atkins, P.W.; "Physical Chemistry", 6th Edition, Oxford University, 1998.
7. Fifield, F.W. and Kealy, D.; "Principles and practice of Analytical Chemistry", 5th Edition, Blackwell Science, 2000.
8. Christian, G.D.; "Analytical Chemistry", 6th Edition., John Wiley, 2004
9. Silverstein, R.M., and Webster, F.X.; "Spectroscopic Identification of Organic Compounds", 6th Edition., Wiley, 1997.
10. Svehla, G.; "Vogel's Qualitative Inorganic analysis", Longman, 1998.
11. Townsends Allen (ed.); "Encyclopaedia of Analytical Science", Academic Press, 1995.
12. Saferstein, R.; "Criminalistics, An Introduction to Forensic Science", 5th Edition, Prentice Hall, 1998.
13. Jeffery, G. H., Bassett, J, Mendham, J, Denny, R.C.; "Vogel's Text Book of Quantitative Chemical Analysis"
14. Kealey, D. and Haines, P.J.; "Analytical Chemistry", Bios Scientific/ Viva Books, 2002.
15. Harris, D.C.; "Quantitative Chemical Analysis", 5th Edition., Freeman, 1999.
16. Parikh C.K; "Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology", CBS Publ. New Delhi, 1999.

### **MFS 234 Information Security and Cyber Crime**

#### **Unit I – Introduction to Cyber Crime**

Cyber Crime- Overview, Internal and External Attacks, Online and offline attacks.

Cybercrimes against Individuals – E-mail spoofing and other online frauds, Phishing and its forms, Spamming, Cyber defamation, Cyberstalking and harassment, Computer Sabotage, Pornographic offenses, Password Sniffing.

Cybercrime against organization – Unauthorized access of computer, Denial-of-service (DOS) attack, Distributed Denial of Service (DDoS) attack, Backdoors and Malwares (virus, Trojan horse, worms), E-mail Bombing, Salami Attack, Software Piracy, Industrial Espionage.

Cyber Security Policy, Security policies violations, Crimes related to Social Media, ATM, phishing/vishing frauds, Online and Banking Frauds. Intellectual Property Frauds. Cyber Crimes against Women and Children, Phases of cyber-attack.

#### **Unit II - Introduction to Computers and Networking**

Introduction to Computer Hardware - Various Components of a Computer, Motherboard, Micro-Processor, Memory, Data Storage Devices and Networking components.

Understanding Computer Operating Systems (OS), Booting process of computers.

Introduction to File Systems and its types.

Networking- Digital and Analog Signaling Methods, Network Types and Topologies,

Different types of IP Addresses, Network Hardware Devices and Client/Server Computing.

### **Unit III – Basics of Information Security**

Information Security - Overview of Information security, CIA Triad, Threats and Vulnerabilities and Risk, Policy, Standards, Procedures, Guidelines and Baselines.

Information Asset Classification: Classification of Information, Information Assets – Owner, Custodian, User. Access control, Authentication and Authorization. Information assurance and defensive measures. Digital Document Security.

Cryptography: Definitions and Concepts, Symmetric and Asymmetric Cryptosystems, Classical Encryption Techniques – Substitution Techniques, Transposition Techniques, Block Ciphers and Stream Ciphers, Hybrid Encryption Techniques, One-Time Pad. E-mail security, Internet and Web Security. Steganography and Steganalysis.

### **Unit IV – Introduction to Digital Forensics**

Digital Forensics- Introduction, Objective and Methodology, Rules of Digital Forensics, First responder - role, toolkit, do's & don'ts; Search and Seizure of Volatile and Non-volatile

Digital Evidence. Imaging and Hashing Digital Evidence, Introduction to deleted file

Recovery; Overview of types of Computer Forensics – Network Forensics, Mobile Forensics, Social Media Forensics and E-mail Forensics. Seizing and preserving mobile devices.

Methods of acquisition of evidence from mobile devices. Data Acquisition and Evidence Gathering from Social Media. Introduction to IT Act.

### **Reference Books**

1. Nina Godbole and Sunit Belapore; "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publications, 2011.
2. Shon Harris, "All in One CISSP, Exam Guide Sixth Edition", McGraw Hill, 2013.
3. Bill Nelson, Amelia Phillips and Christopher Steuart; "Guide to Computer Forensics and Investigations" – 3rd Edition, Cengage, 2010 BBS.
4. William Stallings; "Cryptography and Network Security: Principles and Practices", Fifth Edition, Prentice Hall Publication Inc., 2007.
5. Atul Jain; "Cyber Crime: Issues, Threats and Management", 2004.
6. Majid Yar; "Cybercrime and Society", Sage Publications, 2006.
7. Michael E Whiteman and Herbert J Mattord; "Principles of Information Security", Vikas Publishing House, New Delhi, 2003.
8. Matt Bishop, "Computer Security Art and Science", Pearson/PHI, 2002.
9. Peter Singer and Allan Fredman; "Cybersecurity and Cyberwar: What Everyone needs to know", Oxford University Press, 2014.
10. Raef Meeuwisse; "Cybersecurity for Beginners", Icutrain Ltd., 2015.

**Semester-II****MFS 251: Practical III: Forensic Biology, Forensic Chemistry, and Toxicology**

1. Identification of blood stains using enzymatic and crystal tests
2. Identification of seminal stains using presumptive test, crystal test and detection of spermatozoa
3. Identification of saliva stains
4. Identification of urine stains
5. Microscopic Examination of Human and Animal Hairs
6. Microscopic Examination of Vegetable Fibers
7. Identification of commonly encountered inorganic poisons Arsenic, Antimony, Bismuth, Mercury by colour test and microscopic examination.
8. Identification of ethyl alcohol and methyl alcohol by colour tests and microscopic examination.
9. Identification and comparison of inks by TLC and UV visible spectrophotometry.
10. Analysis of accelerants and incendiary in Arson cases by TLC and UV visible spectrophotometry.
11. Identification of explosives by colour tests & group analysis.
12. Identification of NDPS drugs by colour tests and TLC.

**Semester- II****MFS 252      Practical IV: Forensic Ballistics, Forensic Physics and Information Security****Forensic Ballistics and Forensic Physics**

1. Identification of measure and minor constituents of heterogeneous material evidence
2. Recording of speech samples using cassette and digital voice recorder
3. Sample preparation of calibration curve for UV studies
4. Wet chemical print photography from film negatives
5. Identification, measurement & photography of various components of a road
6. Crime scene videography of simulated crime scene and recording logs of video camera settings
7. Study of details of various small arms – caliber, choke, firing mechanisms, trigger pull, proof marks, etc.
8. Study of details of Shotgun ammunitions and rifle ammunitions
9. Determination of shot-size from diameter and weight of shots.

10. Examination of comparison of class and individual characteristics of fired bullets.
11. Examination and comparison of fired cartridge cases (caliber, firing pin marks, breech face marks, chamber marks, extractor and ejector marks)
12. Chemical tests for powder residue – Walker's Test & barrel wash
13. Test for lead, copper around gunshot holes in different targets.

**Information Security****1. Instrumentation Techniques:**

- Laboratory equipment-handling of Stereo microscope,
- Stereo zoom Microscope,
- Comparison microscope,
- Raman spectrophotometer,
- KAPPA, Nirvis, SEM-EDXA, Docucenter,
- Electro Static Detection Apparatus (ESDA).
- High Resolution Video Spectral Comparators examination,
- Neutron Activation Analysis (NAA).

2. Preliminary examination of documents, identification of natural variations and disguise writings.

3. Secure configuration of ports and services of Windows

4. Encrypting and Decrypting the partition using Bit locker.

5. Collection and preservation of Volatile data from standalone computer.

6. Imaging and recovery of deleted files and folders from storage media.

7. Secure Configuration of Ports and Services of Windows 7.

**MLIF233: BIOANALYTICAL TOOLS AND BIOINFORMATICS****Core Course****Credits: 4****Total Hours: 60****Course objective**

Analytical tools are becoming very important tools in different fields of Biology. The paper deals with the principle, instrumentation and uses of such tools. This course fulfils the basic knowledge in analytical techniques for those students who wish to pursue career in allied health fields and other technical programs.

**Learning outcome**

This course will make the students adept in the working of analytical instruments. They also become confident to use bioinformatics softwares and work with different databases for applications in upcoming fields of biology, which in turn make them competent for jobs in clinical and medical data analysis labs.

**Unit I Introduction to Analytical Biochemistry****5 hours**

Concept of pH, Henderson Hesselbach equation. Importance of buffers in living systems – bicarbonate buffer, phosphate buffer. Breaking of cells by chemical and physical methods, ultrasonication, pressure cell disintegrators, detection of cell-free and cell-bound proteins. Extractions: Preparation of extracts for biochemical investigations, methods of extraction of phytochemicals (Maceration, Soxhlet, Microwave assisted, Ultrasonic, Pressurized liquid extraction) type and choice of solvents.

**Unit 2- Separation techniques****17 hours**

Centrifugation: Principle of centrifugation, the Swedberg equation, types of centrifuges and rotors. Density gradient centrifugation, Cesium chloride and sucrose density gradients; examples of separations, analytical ultracentrifuges. Ultra-filtration -Principle, instrumentation and application. Dialysis-principle and uses. Precipitation- methods and applications. Flow Cytometry; Principle and uses.

Chromatography- principle, types (Column, Ion exchange, Gel permeation, Affinity), Gas chromatography, HPLC, HPTLC

Electrophoresis - buffers, agarose gel electrophoresis, native and SDS -PAGE, Isoelectric focusing, Zymogram, 2 D gel electrophoresis, DGGE, PFGE, Protein staining, trouble shooting,

Protein purification methods, salt fractionation, salting in and salting out, methods of crystallizing proteins

**Unit 3- Spectroscopy****12hours**

Spectroscopy: Absorption and emission spectra. Electromagnetic radiation. Fluorescence and phosphorescence, Beer- Lambert's law, principle, operation and applications of Colorimeter, Spectrophotometer, Concept of Stoke's shift- hypochromicity, hyperchromicity, fluorimeter, flame photometer, Atomic absorption spectrophotometer. IR, Mass spectroscopy and NMR, ICP-MS, GC-MS, LC-MS, X ray crystallography.

**Unit 4 Detection methods****9 hours**

Radioactive isotope, Radioactivity and units of radioactivity (Curie, Rutherford and Becquerel).GM and Scintillation counters. radioactive decay, Radiocarbon dating, autoradiography, use of radioisotope tracer techniques in disease diagnosis, PET scan for tumor



detection, Radioimmunoassay, ELISA, Western Blot, Nanoparticles – synthesis and uses, application of nanotechnology in disease diagnosis and treatment, Microarrays.

**Unit 5: Databases****7 Hours**

Introduction and application of bioinformatics. Definition and types, Nucleotide sequence database - brief note on EMBL, NCBI and DDBJ. Protein structure database [PDB]. Sequence alignment: pair wise and multiple alignments [Definition, applications, BLAST and FASTA, Clustal W, PAM and BLOSUM matrices]. ORF. Structure prediction, and molecular visualization – use of Rasmol, PDB, ExPASy and KEGG. Online tools – SDSC Biology workbench.

**Unit 6: Genomics and Proteomics****5 Hours**

Genomics: Definition. Types [Structural, functional and comparative genomics]. Pharmacogenomics: Definition and its benefits in the health care sector. Genome projects- Human, Rice, Arabidopsis, Tomato, *Hemophilus influenzae*, Proteomics, Transcriptomics and Metabolomics – current status and potential applications in agriculture and medicine. Systems Biology- concept and applications.

**Unit 7 Molecular Phylogeny and drug design****5 hours**

Molecular phylogeny and phylogenetic trees, tools for phylogeny analysis, Computer aided drug design. Docking Studies - Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking, Structure based design of lead compounds and Library docking.

**Essential Reading**

- 1.T. Attwood and P. Smith. Introduction to Bioinformatics, USA: Pearson Education, 2007.
- 2.Brown TA. Genome III. Garland Science Publ.2007
3. Azuaje F & Dopazo J. Data Analysis and Visualization in Genomics and Proteomics. John Wiley & Sons.2005
4. K. Wilson and J. Walker, Principles and Techniques of Biochemistry and Molecular Biology, 7th ed. New York: Cambridge University Press, 2010.
5. S. B. Primrose and R. Twyman R. Principles of Gene Manipulation and Genomics. USA: John Wiley and Sons, 2013.

**Recommended reading**

1. Gibson G & Muse SV. 2004. A Primer of Genome Science. Sinauer Associates.

2. W. Taylor and D. Higgins. Bioinformatics: Sequence, Structure and Databanks: A Practical Approach, Oxford, 2000.
3. Jollès P & Jörmvall H. 2000. Proteomics in Functional Genomics: Protein Structure Analysis.
4. Campbell AM & Heyer L. 2004. Discovery Genomics, Proteomics and Bioinformatics. Pearson Education.

### **MLIF235: Biostatistics**

#### **Core Course**

**Credits: 3**

**Total Hours: 45**

#### **Unit 1. Introduction**

**7 Hrs**

The scope of biostatistics; Classification of study design, Observational studies and Experimental studies (uncontrolled studies, trials with external controls, crossover studies, trials with self-controls, trials with independent concurrent controls); Exploration and presentation of data: Scales of measurement, Tables, Graphs, Histograms, Box and Whisker plots, Frequency polygon, Scatter Plots, Principle component analysis.

#### **Unit 2. Probability:**

**15 Hrs**

Definition, mutually exclusive events and addition rule, independent events and multiplication rule. Sampling: Reasons for sampling, methods of sampling, SRS, Systematic, Stratified, Cluster, NPS. Probability distribution: Binomial, Poisson, Gaussian, Standard normal distribution. Drawing inferences from data: **Tests of significance:** Statistical inference – estimation - testing of hypothesis - t-test, Chi square test (goodness of fit, independence or association, detection of linkages), Z-test, Confidence intervals, Confidence limits, Hypothesis tests, Types of errors, P-values.

#### **Unit 3. Estimating and comparing means:**

**15 Hrs**

Decision about single mean (normal population and non-normal population), decision about single group, decision about paired groups, decision about two independent groups, equality of population variances, computer-aided illustration for comparison of means; Comparing three or more means: ANOVA – one way, two-way, A-priori comparison, Posterior or Post Hoc comparison. Statistical methods for multiple variables: Multiple regression, predicting with more than 1 variable, Statistical test for regression coefficient, Role of R and R<sup>2</sup> in multiple

regression, Confounding variable (ANACOVA), Predicting categorical outcomes – logistic regression, discriminant analysis.

**Unit 4. Correlation and Regression:****8 Hrs**

Pearson's correlation coefficient, Spearman's rho, Linear regression, Least Square method, predicting with regression equation, comparing two regression lines, dealing with nonlinear observation, Common errors in regression, Comparing correlation and regression.

**MLIF251 PRACTICAL IN GENETIC ENGINEERING, BIOANALYTICAL TOOLS AND BIOINFORMATICS****Total credits: 4****Total Hours: 120 Hrs.****Course objective**

The aim of this course is to provide an introduction to recombinant DNA technology. It helps the students to understand how the principles of molecular biology have been used to develop techniques in recombinant DNA technology. The objective of the course is to familiarize the student with the basic concepts in genetic engineering - enzymes, cloning vehicles, gene libraries, analysis and expression of the cloned gene in host cell and understand ethical issues and biosafety regulations. It gives emphasis to practical applications of genetic engineering tools in the field of health care. At the end of the course the student will have enough background of recombinant DNA technology essential for taking up projects in the field of Biotechnology.

**Learning outcome**

Modern Biotechnology relies on rDNA technology. This paper will equip the student with all the basic rDNA methods and protocols. By the end of the course, the students will be familiar with and gain hands on training on basic rDNA methodologies. Moreover, the students will be able to find a job in R&D laboratories/industries where rDNA works are being done.

Sl. No.	Name of the experiment
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**Genetic Engineering**

- |   |   |
|---|---|
| 1 | Isolation and purification of DNA from plant, animal, bacterial and fungal samples. |
| 2 | Isolation of plasmid DNA from the bacteria.   |

- 3 Isolation of RNA from plant, animal and bacterial samples and separation on denaturing gel.
- 4 Primer design and PCR amplification of DNA.
- 5 Gel-band purification for DNA.
- 6 RFLP and RAPD, ISSR/SSR analysis of DNA
- 7 Cloning and expression of gene in *E. coli*.
- 8 Southern blotting and hybridization.
- 9 Agarose gel electrophoresis.
- 10 Study of star activity of restriction Enzyme.
- 11 Study of complete and partial digestion of DNA.
- 12 Effect of different parameters on Restriction digestion.
- 12 Site directed mutagenesis

**Bioanalytical Techniques**

- 13 Analysis of Amino Acids and Sugars (TLC and Colorimetric)
- 14 Extraction of phytochemicals using Soxhlet apparatus
- 15 Column Chromatography
- 16 Affinity chromatography.
- 17 HPLC- Principle and sample preparation, visit to Research Institute for analysis
- 18 Zymogram
- 19 Microwave assisted extraction
- 20 Density Gradient Centrifugation
- 21 Dialysis and purification of proteins
- 22 Isoelectric focusing
- 23 Colorimetry and spectrophotometry

**MFS 331 Forensic Anthropology****Total credits: 4****Total Hours: 60 Hrs.****Course type:** Core Course

Course Objectives:

The objective of this course is to explain the relevance of personal identification and its application using somatometric and somatoscopic observation, tattoo marks, deformities and genetic traits in forensic investigations. It will also explain the basic principles of human growth and development with focus on methods of assessing age-especially dental age and skeletal age. The course would highlight the forensic morphometry of skeletal remains, skeletal analysis and details of forensic odontology

#### Unit 1

##### Personal Identification

Genesis and development of forensic anthropology. Personal identification of living persons Identification through somatometric and somatoscopic observation, nails, occupation marks, scars, tattoo marks and deformities; handwriting and mannerisms. Genetic traits of forensic significance: Colour blindness, ear lobe, brachydactyly, polydactyly, widow's peak, eye colour, hair colour, face form, frontal eminences, nasal profile, nasal tip, lips, chin form. Identification of the recently dead and decomposed bodies.

#### Unit 2

##### Human Growth and Development

Major stages of human growth and development- Prenatal growth, Postnatal growth and their characteristics, Factor affecting growth- Genetic and Environmental. Methods of studying Human Growth, Significance of age in growth studies Methods of assessing age-chronological age, dental age, skeletal age, secondary sex character age and morphological age .

#### Unit 3

##### Forensic Morphometry of Skeletal Remains

Techniques for recovering skeletonised human remains. Laboratory analysis of skeletal and decomposing remains; maceration, skeletal analysis. Human and Animal remains. Bone fragments, Attribution of sex, estimation of age and reconstruction of stature from skeletal remains. Trauma analysis and identifying skeletal pathology. Antimortem, perimortem, post-mortem and pseudo mortem trauma. Pathological changes in bone. Establishment of partial and complete identity of skeletal material and dead bodies-morphometric techniques.

#### Unit 4

##### Forensic Odontology

Tooth structure and growth. Estimation of age from odontological evidences. Population differences in size and morphology. Individualisation of tooth pulp. Bite marks and its forensic

significance. Photography, lifting and preservation of bite marks. Comparison and evaluation of bite mark evidences.

#### Course Learning Outcome

CO 1 To understand genesis and development of forensic anthropology.

CO 2 To discuss major stages of human growth and development and different methods of assessing age.

CO3 To describe techniques for recovering skeletonised human remains and their laboratory analysis.

CO 4 To learn methods of age estimation from odontological evidences.

#### Suggested Readings

1. Reddy, V.R; Dental Anthropology, Inter-India Publication, New Delhi, 1985.
2. Singh, I.P. & Bhasin M.K; A manual of biological Anthropology, Kamla Raj Enterprises, New Delhi, 2004.
3. Kroeber; Anthropology, Oxford & IBH Publishing Company, New Delhi, 1972.
4. Pickering, R. & Bachman D; The use of Forensic Anthropology, CRC Press, Costa Rica, 2009.
5. Bose, N K; Anthropology, Narayana Press, Denmark, 1972.
6. James, R; Forensic examination of hair, Taylor & Francis, 2ND Ed. London, 1999.
7. Shubhra, G; Introduction to forensic examination, Selective Scientific Books, New Delhi, 2008
8. Michael, W. Haney, H.A. & Freas, L.E; The Forensic Anthropology Laboratory, CRC Press, 2008.
9. Eveleth, P.B. & Tanner, J.M; Worldwide Variation in Human Growth, Cambridge University Press, London, 1976.

### **MFS 332 FORENSIC DERMATOGLYPHICS AND OTHER IMPRESSIONS**

#### Course Objectives:

The objective of this course is to explain the concept of dermatoglyphics and other impression with their forensic implication. It will also familiarize students with the biometrics, technology involved and multibiometric systems. The course also aims to discuss the foot/ footwear/tyre impressions lip prints, ear prints and their significance in forensic investigations

## Unit 1

### Fingerprints and Palm prints

History and development of Dermatoglyphics, formation of ridges, pattern types, pattern area. Classification of fingerprints- Henry's system of classification, single-digit classification, Extension of Henry's classification, filing, searching and fingerprint bureau. Composition of sweat, development of chance, latent, visible and plastic prints. Conventional methods of development of latent prints- fluorescent methods, magnetic powder method, fuming method, chemical method etc. Application of laser and other radiations to develop latent fingerprints, metal deposition method and development of latent prints on skin. Taking of fingerprints from living and dead person, preserving and lifting of fingerprints, photography of fingerprints. Ridge counting and ridge tracing, class and individual characteristics, various types of ridge characteristics. Comparison of palm prints on the basis of individual ridge characteristics. Automated Fingerprint Identification System (AFIS). Modern methodologies in fingerprinting.

## Unit 2

### Biometrics

Biometric evidences such as finger impressions, retina, iris pattern, voice, gait pattern, face recognition, 3D face recognition, automatic forensic dental identification, hand vascular pattern technology, Multibiometric systems, Recent developments, biometric databases.

## Unit 3

### Foot/ Footwear/Tyre impressions

Importance, Gait pattern, Casting of footprints in different medium, electrostatic lifting of latent footprints. Taking of control samples. Collection, tracing, lifting, casting of impressions, enhancement of footwear impressions, analysis and comparison of foot impressions, moulds, identification characteristics.

## Unit 4

### Lip prints, Ear prints and their significance

Nature, location, collection and evaluation of lip prints. Forensic Significance, photography, location, collection and evaluation, taking of control samples of footprints, lip prints and Ear prints for comparison. Modern techniques and developments.

### Course Learning Outcome

CO 1 To understand the history and development of Dermatoglyphics, different classifications used and Modern methodologies in fingerprinting.

CO 2 This paper furthermore addresses the use of biometric evidences.

CO 3 To learn methods of taking footprints, their collection and identification of characteristics.

CO 4 To analyse lip prints and their forensic significance.

#### Suggested Readings

1. Bridges, B.C; Criminal Investigation, Practical Fingerprinting, Thumb Impression, Handwriting expert Testimony, Opinion Evidence., Univ. Book Agency, Allhabad, 2000
2. Mehta, M.K; Identification of Thumb impression & cross examination of Fingerprints, N.M. Tripathi Pub. Bombay, 1980.
3. Chatterjee, S.K; Speculation in Fingerprint Identification, Jantralekha printing Works, Kolkata, 1981.
4. Cowger James F; Friction Ridge Skin- Comparison & Identification of Fingerprints, CRC Press, NY, 1993
5. Cossidy, M.J; Footwear Identification, Royal Canadian, Mounted Police, 1980.
6. Iannavelli, A.V; Ear Identification, Forensic Identification Series, Paramount, 1989.
7. Henry, C.L. & Ganesslen, R.E; Advances in Fingerprint Technology, CRC Press, London, 1991.
8. Jain, A.K., Flynn, P. & Ross A.A., Handbook of Biometrics, Springer, New York 2008.

#### MFS 333 Forensic Genetics & Forensic Serology

##### Unit I

Human genetic variations. Mendelian Inheritance. Hardy Weinberg Equilibrium. Mutation- their types and causes. Relevance of population genetics. Allele frequency, genotype frequency. Polymorphism and heterozygosity. Measures of genetic variations.

##### Unit II

Determination of species of origin- ring test, single diffusion in one dimension and two-dimension, double diffusion in one dimension and two dimensions, immunoelectrophoresis, Rocket immune-electrophoresis, Two dimensional electrophoresis, cross-over electrophoresis, Anti-human globulin serum inhibition test, passive hemagglutination method, precipitin-inhibition test, mixed agglutination method, sensitized latex particle method. Testing Procedures and factors affecting precipitin tests. Raising of Anti-sera, buffers and serological



reagents, Lectins and their forensic significance, methods of sterilization employ for serological work

### Unit III

Human blood group systems. History, biochemistry and genetics of ABO, Rh, Mn and other forensically significant blood group systems. Methods of ABO blood grouping (absorption-inhibition, mixed agglutination and absorption elution) from blood stains and other body fluids/stains. New approaches in bloodstain grouping. Blood group specific ABH substances. Secretors and non- secretors. Blood groups that make racial distinctions. Lewis antigen. Bombay Blood groups. HLA antigens and HLA typing. Role of sero-genetic markers in individualization and paternity disputes. Pitfalls in red cell typing.

### Unit IV

Red cell enzymes: Genetics, Polymorphism and typing of PGM, GLO-I, ESD, EAP, AK, ADA etc. and their forensic significance. Serum proteins: Genetics, polymorphism and typing of – Hb, HP, Tf, Bf, C3 etc. and their forensic significance. Non-genetic approaches to individualization- biochemical profiling, antibody profiling and persistent disease agents.

### Reference Books:

1. Goodwin, William; “An Introduction to Forensic Genetics”, John Wiley & Sons Ltd., 2007.
2. Kapur, V; “Basic Human Genetics”, Jaypee Brothers, 1991.
3. Kothari, Manu L; “Essentials of Human Genetics”, University Press (India) Pvt. Ltd., 2009.
4. Singh B.D.; “Fundamentals of Genetics”, Kalyani Publishers, 2006.
5. Edmund Sinhatt; “Principles of Genetics”, McGraw Hill Publications, 1950.
6. Giblett, Eloise R.; “Genetic Markers in Human Blood”, Blackwell Scientific Publications, 1969.
7. Altenburg, Edgar; “Genetics”, Oxford & IBH Publishing Co., 1970.
8. GJV Nossal; “Antigens, Lymphoid Cells and the Immune Response”, Academic Press, 1971.
9. Wiener, Alexander S; “Advances in Blood Grouping II”, Grune & Stratton, 1965.
10. Boorman, Kathleen E & Churchill; “Blood Group Serology”, Livingstone, 1977.
11. Race, R.R, Blackwell; “Blood Groups in Man”, Scientific Publications, 1975.
12. Sussan, Leon N & Charles Thomas; “Paternity Testing by Blood Grouping”, 1968.
13. Prakash, M; “Physiology of Blood”, Anmol Publications, 1998.

14. Gupta, S.K; “Essentials of Immunology”, Arya Publications, 2008.
15. Franklinns Stahl; “The Mechanism of Inheritance”, Prentice Hall, 1969.
- 16.Gell, P.G.H; “Clinical Aspects of Immunology”, Blackwell Scientific, 1975.

### Semester-III

#### MFS-333 Forensic DNA Profiling and Bioinformatics

##### Unit I

Structure and function of DNA, RNA and genome organization. Denaturation and Renaturation of DNA, Milestones in development of DNA technology. History of Forensic DNA Testing. Enzymes used in manipulation of nucleic acids. Probes. Genetic basis of Forensic DNA typing, Technological basis of Forensic DNA typing.

##### Unit II

Sample collection and preservation. DNA Extraction Methods. Quantification and Quality assessment methods. PCR amplification – PCR process, components, controls, advantages and disadvantages, types of PCR, PCR inhibitors, optimization and solution to PCR inhibition. Stochastic effect. PCR Primer designing. DNA separation methods: Slab gel and Capillary Electrophoresis. Capillary electrophoresis-Principle and Instrumentation. DNA detection methods: Fluorescent Dyes and Silver–staining.

##### Unit III

Forensic DNA typing system – RFLP, Amp-RFLP. STR. Mini STR. Y-STR. XSTR. Mitochondrial DNA. Single Nucleotide Polymorphism. Microbial DNA testing, Non-Human DNA testing, Plant DNA testing. STR allele nomenclature. STR loci of Forensic significance. STR kits. STR typing: Manual and Capillary Electrophoresis. Gender identification. Interpretation of the DNA typing results. CODIS, Statistical evaluation of DNA typing results and preparation of reports. RNA and its application in Forensics, Emerging molecular techniques in Forensics.

##### Unit IV

Introduction to bioinformatics and its application in forensics. Integrated information retrieval. Major databases in bioinformatics. Sequence alignment, Phylogenetic analysis and related tools. Gene identification and prediction. FASTA and BLAST algorithm. Bioinformatics analysis of DNA Microarray, Bioinformatics tools of forensic applications- Clustal family, BioEdit, MEGA, Arlequin, Protein structure prediction and visualization tools. Tools used in proteomics, In-silico simulation for molecular biology experiments. Basic theory of probability

and statistics. Bayesian analysis. Likelihood ratio. Statistical evaluation of DNA profiles using Bioinformatics tools.

Reference Books:

1. Rudin, Norah; "An Introduction to Forensic DNA Analysis", CRC Leviw Publishers, 2002.
2. Inman, Keith; "An Introduction to Forensic DNA Analysis", CRC Press, 1997.
3. Vij, Krishan; "Basics of DNA and Evidentiary Issues", Jaypee Brothers, 2004.
4. Kirby, Lorne; "DNA Fingerprinting", W H Freeman and Co., 1992.
5. Nickoloff, Jac A; "DNA Damage and Repair", Humana Press, 1998.
6. Easteal, Simon; "DNA Profiling", Harwood Academic Publishers, 1993.
7. Epplen, Jorg T.; "DNA Profiling and DNA Fingerprinting", Birkhauser Verlage, 1999.
8. Lorne Kirby; "DNA Fingerprinting", W H Freeman and Co., 1992.
9. Singh, Yashpal; "DNA Tests in Criminal Investigation Trial & Paternity Disputes", Alia Law Agency, 2006.
10. J.M. Butler; "Forensic DNA Typing", Elsevier Academic Press, 2005.
11. Mark A. Farley & James J. Harrington; "Forensic DNA Technology", CRC Press, 1991.
12. S.C. Rastogi, N. Mendiratta & P. Rastogi; "Bio-informatics – Methods and Applications", PHI learning Pvt. Ltd., 2009.
13. Dr. Westhead, JH Parish & R.M. Twyman; "Bio-informatics", Viva Books Ltd., 2003.
14. "DNA Technology in Forensic Sciences", National Research Council, National Academy Press, 1997.
15. G.A O'Gaal, Medgyeri et al; "Electrophoresis in the separation of Biological Macromolecules", John Wiley & Sons, 2008.
16. JM Claverie and Cedric Noterdame; "Bioinformatics – A Beginner's Guide", Wiley Publications, 2008.
17. Alcamo, I Edward; "DNA Technology", Harcourt Academic Press, 1999.
18. T. Burke & Terry; "DNA Fingerprinting: Approaches and Applications", Birkhauser Verlage, 1999.
19. JP Baride, A.P. Kulkarni & R.D. Muzumdar; "Manual of Biostatistics", Jaypee Publications, 2003

20. J. Thomas McClintock; "Forensic DNA Analysis", Lewis Publications, 2008.
21. "Methods in Biostatistics", 7th Edition, Jaypee Publication, 2010.
22. P.S.S Sundar Rao and J.Richard; "Introduction to Biostatistics and Research Methods", 5th Edition, 2012.

### Semester-III

#### **MFS 352 Practical VI: Forensic Serology, DNA profiling and Bioinformatics**

**Credits – 4**

**Hours: 120**

##### **Forensic Serology**

1. Determination of species of origin of blood, semen and saliva.
2. ABO grouping of bloodstains by absorption elution, absorption inhibition and mixed agglutination techniques.
3. ABO grouping from hair root
4. Rh grouping of bloodstains
5. MN grouping of blood stains
6. Determination of secretor status from saliva by inhibition techniques.
7. Experiments on electrophoresis of red cell isozymes viz. PGM, GLO, EsD, EAP, ADA, AK.
8. Experiments on electrophoresis of serum proteins Hp, Tf, C3, Bf, Gc etc.
9. Experiments on separation of SAP/VAP.
10. Preparation of Lectins and titration.
11. Experiments on reactivity of Lectins against body fluids and tissues

##### **Forensic DNA Profiling**

1. DNA Extraction from biological samples ( Blood and other body fluids and tissues) using Organic (Phenol-Chloroform) Method
2. DNA Extraction from biological samples using Chelax Method.
3. DNA Extraction from biological samples using Salting out Method.
4. DNA Extraction from biological samples using FTA Cards.
5. DNA Extraction from biological samples using commercially available kits

6. Qualitative and Quantitative Analysis using Agarose, UV Spectrophotometer and Real time-PCR.
7. PCR Amplification of DNA samples
8. Post-PCR Agarose gel electrophoresis of PCR products.
9. Amp-RFLP Analysis of biological samples
10. STR typing using vertical poly-acrylamide gel electrophoresis and silver staining.
11. STR typing using Genetic Analyzer.

**Bioinformatics**

1. Docking studies of ligands
2. Construction of dendogram
3. Pubmed
4. BLASTN, BLASTP and BLASTX
5. FASTA
6. KEGG
7. EXPASY
8. RasMol

**Semester-III****MFS 351 Practical V: Forensic Anthropology****Credit – 2****Hours: 60**

1. Morphological & microscopic examination of hair.
2. Examination of blood stains: physical and chemical tests; spectroscopic examination.
3. Examination of seminal stains: crystal tests, chemical, biochemical, microscopical and electro-immuno-diffusion test.
4. Examination of saliva and its stains: microscopical and chemical tests.
5. Examination of urine stains.
6. Faecal stains: chemical and microscopical examination, testing of urine and sweat.
7. Menstrual blood and its examination by microscopic and electrophoretic methods.
8. Identification of human bones and determination of their sides.
9. Determination of age from skull, teeth, sex from skull and pelvis

10. Stature estimation from long bones.

11. Taking of finger, palm and sole prints and their analysis.

### **MSF 335 Fundamentals of Forensic Psychology**

**Credits – 3**

**Hours: 45hrs**

Unit-I Basics: Forensic Psychology and the Law, Ethical Issues in Forensic Psychology, Civil and criminal case assessment, Assessing mental competency, Mental disorders and Forensic Psychology, Eye witness testimony, Criminal profiling- need and types, Forensic Scientific evidence, Crime and Psychopathology, Genetics and Crime, Serial murders, Modus Operandi.

#### **Unit II**

Psychological Assessment: Psychological Assessment Tools, Detection of deception, Various methods for detection of deception, Interview, Non-verbal detection, statement assessment, Hypnosis, Psychological assessment, voice stress analyzer, Polygraph, thermal imaging, Brain Electrical Oscillation Signature Profiling, Functional Magnetic Resonance study, Current research in detection of deception/truth finding mechanisms

#### **Unit III**

Polygraph: Historical aspects of Polygraph, Principles of polygraph, psycho physiological aspects, operational aspects, Question formulation techniques, Interviewing technique procedure, The Art-Polygraph, Legal and Ethical aspects, Human rights of individual.

#### **Unit IV**

Narco-Analysis: Historical aspects, Principle and Theory, General Procedure –Legal and Ethical aspects, Human rights of individual. Brain Electrical Oscillation Signature (BEOS) Profiling: Principle and Theory, General Procedure – Legal and Ethical aspects, Human rights of individual

#### **References:**

1. Forensic Science in Criminal Investigation & Trials – B.R.Sharma
2. The Hand Book of Forensic Psychology – Weiner Hass
3. Hand Book of Forensic Psychology – O' Donohue Levensky
4. Brain Experience – C.R.Mukun
5. Criminal Profilling – B.Turvey
6. Investigative Forensic Hypnosis – J. Niehans

7. Art & Science of the Polygraph Techniques – J.A.Matte
8. Hand Book of Polygraph Testing – M.Kloinen
9. Detecting Lies & Deceit – A.Vri

## **FOURTH SEMESTER**

### **MFS 441 A Forensic Drugs Analysis**

Unit-I Drug: Definition of Drug, Drug Use & Misuse, Drug Chemistry, Drug Dependence and chemistry of Addiction, Drug Receptors and Brain Chemistry. Drugs of Abuse: Definition, Classification based on Form and Origin, Use, Effects and Schedules, Structure of NDPS Act and the definitions of each drug classification, Drugs as Evidence, Profiling Examples of Illegal Drugs, United Nations International Drug Control Programme.

Unit-II Chemistry and Analysis of Drugs of Abuse: Origin, Pharmacology, Methods of preparation, Storage, Diluents and Adulterants, Sample Handling, Optimization of Experimental Conditions, Presumptive/Screening and Confirmatory Methods: Color/spot test, Microscopic examination, Microcrystalline tests, Thin-Layer Chromatography, Sample Preparation before TLC Specimen, Extraction Evaluation of TLC for Drug Screening, Immunoassay Methods, UV Spectrophotometry, IR/FTIR Spectrophotometry, NMR, GC-MS & HPLC/LC-MS, Legal Implications and Data Interpretation of Opium and Opioids analgesics, Stimulants (Cocaine, Amphetamine & other amphetamine derivatives), Depressants (Barbiturates and Benzodiazepines), Hallucinogens (Cannabis, LSD, Psilocybine and Mescaline), OTC, Inhalant and Volatile Substances, Drugs in sexual assault

#### Unit-III

Clandestine laboratory: Meaning and Definition of Clandestine, Clandestine Laboratory, Related Problems, Factors Contributing to Clandestine Drug Labs, Harms Caused by Clandestine Drug Labs, Equipment Needs: Reflux, Distillation, Hydrogenation, Bucket Chemistry, Extractions, Chemical Needs, Cooking Methods Commonly Used in Clandestine Drug Labs, Extraction Process, Conversion Process, Synthesis Process, Tableting.

Designer drugs: Definition, Analogs of Fentanyl and Meperidine (both synthetic opioids), Phencyclidine (PCP), Amphetamines and methamphetamines (which have hallucinogenic and stimulant properties). Laboratory Analysis: The Chemist, Extractions: Physical Extraction, Dry Wash/Extraction, Liquid/Liquid Extractions, Analysis: Chemical Color Tests, Microscopic Techniques, Infrared Spectroscopy, Thin-Layer Chromatography, Ultraviolet Spectroscopy, Gas Chromatography. Format of NDPS Report Writing & Court Room Testimony.

Unit-IV Drug Abuse in Sports: Introduction, International Olympic Committee (IOC), World Anti-Doping Agency (WADA), classification of commonly prohibited substances and Performance enhancing Drugs, Steroids, Stack and Pyramid methods, Dope test and Blood Doping, Sampling techniques, analytical approaches.

Suggested Readings:

1. Clarke's Analysis of Drugs and Poisons, (Formerly Isolation & Identification of Drugs) 3rd Ed. 2 Vol. Set.
2. Clark, E.G.C. : Isolation and identification of Drugs, VI and Vol. II, 1966, 1975-1986.
3. Modi, Text Book of Medical Jurisprudence Forensic Medicines and Toxicology (1999) CBS Pub. New Delhi
4. Saferstien (1982) Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA.
5. DFS -Working Procedure Manual- Narcotics
6. E. Stahl (1969) Thin Layer Chromatography: A Laboratory Handbook.
7. Saferstein (1976) Criminalistics.

### **MFS 441 B: Analytical Forensic Toxicology**

#### **Unit-I**

Samples required in Toxicological analysis: Selection of Post-mortem samples and reference to particular class of poison, Classes of samples (Biological and Non-biological), Methods of sample collection (Living and Dead person), Classification of matrices, choice of preservatives, containers and storage conditions.

Alternative specimens: Hair analysis, Drugs in oral fluid, Detection of drugs in sweat etc.nAnalysis of Exhumed and decomposed bodies.

#### **Unit-II**

Alcohol Intoxication & analysis: Related cases, Properties and types of Alcohols, Pharmacology, Toxic properties and effects of alcohol. Chemical tests for alcohol in blood and urine including Breath Alcohol Screening devices, Method of analysis of some alcoholic beverages in biological materials by chemical methods (Kozelka- Hine) and instrumental methods (GC), Legal context to drinking and driving.

Format of Report Writing & Court Room Testimony: Information required by the Forensic toxicologist, Presenting findings in a Report format.



### Unit III

Animal Poisons: Insects and animal toxins and their examination, Composition of Snake venoms, Sites and mode of action, Effect on the body as a whole, and tests for identifications. Plant poisons: Classification and characteristics, method of extraction and stripping of plant poisons in matrices and analysis by chemical and instrumental techniques.

### Unit IV

Gaseous Poisoning: Carbon Monoxide, Hydrogen Cyanide and Phosphine gas, significance, signs and symptoms, methods of diagnosis, tests for identification.

Food Poisoning: What is food poisoning, Food poisoning due to chemical and bacterial, Sign and symptoms of food poisoning, collection and preservation of evidence material, extraction and isolation, from food material, Biological material, detection and identification by colour test and Instrumental techniques.

#### **Suggested books:**

1. DFS Manual of Forensic Toxicology
2. A C Moffat Clarke's Analysis of Drugs and Poisons, (Formerly Isolation & Identification of Drugs) 3rd Ed. 2 Vol.
3. Casarett & Doll Toxicology (2003) The Basic Science of poisons.
4. Clark, E.G.C. : Isolation and identification of Drugs, VI and Vol. II, 1966, 1975-1986.
5. Curry A.S (1986) Analytical Methods in Human Toxicology, Part II, CRC Press Ohio
6. Curry, A.S. (1976) Poison Detection in Human Organs.
7. Michael J. Deverlanko et al (1995) Hand Book of Toxicology CRC Press.
8. Morgan B.J.T (1996) Statistics in Toxicology, Clarendon Press, Oxford.
9. Modi, Text Book of Medical Jurisprudence Forensic Medicines and Toxicology (1999) CBS Pub. New Delhi
10. Saferstien (1982) Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA.

#### **Practical VII: Forensic Drugs Analysis and Analytical Forensic Toxicology**

##### **Forensic Drugs Analysis**

1. Identification of common precursors.
2. Identification of narcotic drugs: opium and alkaloids, morphine and heroin, cannabis by colour test TLC, and instrumental techniques.

3. Analysis of Ganja and charas by color test, TLC/HPTLC
4. Determination of barbiturate by UV -visible Spectrophotometric method.
5. Determination of morphine and heroin in a given sample by UV-visible spectrometer/ LC.
6. Determination of morphine and heroin in a given sample by GLC method.
7. Identification of ketamine by color test & TLC.
8. Analysis of stimulants by color tests, TLC/HPTLC.
9. Identification of unknown seized NDPS Drug by chemical methods and Instrumental techniques.
10. Extraction of drugs from hair sample.
11. Study of FTIR spectra of benzodiazepines & Narcotics.

### **Analytical Forensic Toxicology**

1. Analysis of viscera for volatile poisons (Organic and Inorganic) by Conway apparatus.
2. Detection and identification of metallic poisons in viscera and food material by chemical test and instrumental technique.
3. Analysis of viscera for organochloro, organophosphoro, carbamates and pyrethroids by colour test TLC/HPTLC and UV-visible spectrometry method.
4. Determination of alcohol in blood and urine sample.
5. Systematic extraction, and identification of non –volatile drugs and plant poisons by various techniques.
6. Identification of common plant poisons opium and alkaloids, Kaner, Dhatura and Nux Vomica, Aconite by colour test, cannabis and instrumental techniques.
7. Detection and identification of quarternary ammonium drugs and poison in viscera by ion pair method and instrumental method.
8. Determination of phosphine in aluminum phosphide and zinc phosphide in viscera by chemical and instrumental analysis.
9. Identification of psychotropic drugs- barbiturates, benzodiazepines & narcotics in biological fluids by colour test, TLC/HPTLC and instrumental techniques.

10. Detection and identification of major metabolites of ethanol, methanol, parathion, carbaryl and heroin.

11. Systematic analysis of unknown poisons.