# Scheme for M. Sc. Forensic Science & Criminology (Semester System)
**Panjab University, Chandigarh**  
2017-18, 2018-19 & 2019-20

## 1st Semester

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>Theory</th>
<th>Practical</th>
<th>Total Marks</th>
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<tbody>
<tr>
<td>FSC-101 T</td>
<td>General Forensic and Fingerprint Science</td>
<td>100</td>
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<tr>
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<td>FSC-102 T</td>
<td>Forensic Biology</td>
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<td>FSC-103 T</td>
<td>Instrumentation</td>
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<tr>
<td>FSC-104 T</td>
<td>Criminology, Criminal Law and Forensic Psychology</td>
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<tr>
<td>FSC-105</td>
<td>Crime file/Scrap File</td>
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Total = 600

## 2nd Semester

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<tr>
<td>FSC-201 T</td>
<td>Molecular Biology and Biochemistry</td>
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<td>Quality Management and Statistics</td>
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Total = 600

## 3rd Semester

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<tr>
<td>FSC-301 T</td>
<td>Forensic Toxicology and Drugs of Abuse</td>
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<td>FSC-302 T</td>
<td>Ballistics</td>
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<td>FSC-303 T</td>
<td>Forensic Anthropology, Osteology and Odontology</td>
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<td>FSC-403 T</td>
<td>Advanced DNA Methods*</td>
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<td>FSC-404 T</td>
<td>Forensic Explosives*</td>
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<td>Forensic Audio-Video Analysis*</td>
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<td>Dissertation</td>
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<td>Seminar/Journal Club</td>
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**Total = 600**

Note:

*FSC-403 T&P: Students with Specialization in Forensic Biological Sciences
*FSC-404 T&P: Students with Specialization in Forensic Chemical Sciences
*FSC-405 T&P: Students with Specialization in Forensic Physical Sciences

Grand Total = 2400
Forensic science is the application of a broad spectrum of sciences to answer questions of interest to a legal system. This may be in relation to a crime or a civil action. The paper covers all general aspects of forensic science including definition, nature, needs and evaluation pertaining to forensic investigations. Fingerprint sections include history, development, classification and all the scientific aspects regarding preserving and examination.

**UNIT-I**

1. Nature, Need and Alternatives to forensic science
2. Evidence: Types and relevance, Laws and Principles
3. Problems of proof: General, Scientific evidence and proof, Investigative problems, Scientific aspects, Legal problems
5. Court: Fallacies about expert evidence
6. Frye case & Daubert Standard

**UNIT-II**

2. Scene Management Documentation: Scene Description, Photographic and Sketching Documentation, Evidence Recovery and Possession Log
3. Criminal Profiling: Overview, Inductive and deduct method, Analysis and reconstruction, Offender characteristics

**UNIT-III**

1. History and development of fingerprint Science, formation of ridges, pattern types, pattern areas, Fundamental Principles and levels of Fingerprints
2. Classification of fingerprints – Henry system of ten digit classification, Extension of Henry system, search of fingerprints, Battley’s Single digit classification, fingerprint Bureau, Poroscopy and Edgioscopy
3. Composition of sweat, chance fingerprints: latent & visible fingerprints, plastic fingerprints.
5. Application of laser and other radiations to develop latent fingerprints, metal deposition method and development of latent prints on skin.
UNIT-IV

1. Taking of finger prints from living and dead persons,
2. Preserving and lifting of fingerprints, photography of fingerprints, Digital imaging and enhancement.
3. Comparison of fingerprints, basis of comparison, class characteristic, individual characteristic, various types of ridge characteristics
4. Automatic fingerprint identification system, Expert Opinion Writing
5. Other prints: Lip print, palm print, foot print and Ear print- their applications.

Recommended Books

2. Saferstein, R., 1976, Criminalistics : An Introduction to Forensic Science

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>FSC-101P</td>
<td>General Forensic and Fingerprint Science Practical</td>
<td>Total: 50</td>
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</tbody>
</table>

1. Study and evaluation of crime case histories on forensic aspects.
2. Crime scene sketching: Blank, Indoor and Outdoor
3. To take plain and rolled inked finger prints
4. Taking of palm prints
5. To identify the finger print patterns
6. To identify core and delta
7. To perform ridge tracing and ridge counting
8. To identify ridge characteristics
9. Development of latent prints by mechanical methods, fuming and chemical methods on various surfaces
10. Lifting of finger prints and photography
11. Ten digit fingerprint classifications
12. To compare the finger prints

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<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>FSC-102T</td>
<td>Forensic Biology</td>
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<td>Semester Exam: 80</td>
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<td>Internal Assessment: 20</td>
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</table>

Forensic biology is introduced with all its components i.e. forensic entomology, serology, botany, wildlife, limnology etc. It deals with forensic entomology, forensic wildlife, and forensic botany. This unit gives the students an insight into the life of other living organisms, which in turn will make them aware of the factors and features associated with the same thereby producing meaningful and substantial evidence. Forensic botany comprises of wood, leaves, pollen and diatoms and their usage as forensic evidence. The DNA barcoding as a tool to identify these forensic evidences is introduced. It also covers often neglected but important evidences such as hair and fibers. It includes the study of various properties useful in forensic comparisons along with the collection procedures. It covers the most encountered body fluids at a crime scene along with their nature, forensic characterization and collection. It also covers the upcoming techniques of biomolecule identification like aptamer and affibody based techniques.

UNIT-I

1. Forensic Biology: General Concept and Definitions, History and Nature, Classification of different biological evidences, Principals of collection and preservation of biological exhibits
2. Animals, Plants and Microorganisms in Legal Investigation: Basic Principles, Tools and Techniques
3. Forensic Entomology: General entomology and arthropod biology
4. Insects of forensic importance
5. Collection of entomological evidence during death investigations
6. Insect succession on carrion and its relationship to determine time since death, its application to Forensic Entomology

UNIT-II

1. DNA barcoding for Species identification
2. DNA barcoding of Plant, fungi and animals
3. Challenges in DNA barcoding of forensic samples and their solution
1. Databases of DNA barcodes
2. International missions/facilities/projects on DNA barcoding
3. Applications of DNA barcoding in forensics: drug adulteration, wildlife crime, associative evidence at crime scene (wood leaf, pollen, spores, diatoms)
4. Aptamers and affibody: forensic applications
5. Protein engineering and invitro evolution for making proteins for forensic application

**UNIT-III**

1. Hair: Morphology of hair Cuticle cortex and medulla area of hair
2. Three phases of hair growth
3. Distinction between animal and human hair
4. Hair features useful for microscopic comparison of human hair
5. Wild Life Forensics: Introduction & importance
6. Pollen: Structure, function, methods of identification and comparison
7. Diatoms: Nature, location structure, extraction from various body tissues, including bone marrow, preparation of slides, methods of identification and comparison, forensic significance

**UNIT-IV**

1. Body Fluids: The nature of blood
2. Chemical and Microscopic Analysis of Biological Stains
3. Screening Evidence for Biological Stains in Forensic Casework
4. Species of Origin and Serology Separation Techniques
5. ABO Grouping and Secretor Status, List of ABO antigens and antibodies in blood
6. Principles of heredity
7. Biological Markers of Forensic Significance
8. Forensic characterization of blood, Preservation of suspected blood
9. Concept of antigen-antibody reaction and application to species identification
10. Monoclonal and polyclonal antibodies
11. The nature of semen Forensic characterization of semen, semen stains for laboratory examination
12. The nature of saliva, forensic characterization of saliva

**Recommended Books**

1. An Introduction to Forensic Science by Richard Saferstein (Prentice Hall College Div; 8th edition)
2. Essential Forensic Biology: Animals, Plants and Microorganisms in Legal Investigation by Allen Gunn
3. The biochemistry of semen and male reproductive tract Thaddeus Mann Methuen &Co. Ltd. London 1964
4. Biology methods Manula Metropolitan Police Forensic Science Laboratory
<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tr>
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<td></td>
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<td>Internal Assessment: 10</td>
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<tr>
<td>1.</td>
<td>Sample preparation of hairs, human and animal hair morphology,</td>
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<td>measurements (diameter, medullary ratio)</td>
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<td>2.</td>
<td>Human hair comparison, colour, treatment, pigment shape and</td>
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<td>distribution, damage, disease, medulla, root, tip – Animal hair</td>
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<tr>
<td></td>
<td>diameter, medulla, color banding, scale casts</td>
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<tr>
<td>3.</td>
<td>Vegetable fiber characterization</td>
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<tr>
<td>4.</td>
<td>Tests for saliva</td>
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<tr>
<td>5.</td>
<td>Presumptive/confirmatory tests for blood and semen</td>
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<td>6.</td>
<td>RT PCR based identification of human tissue</td>
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<tr>
<td>7.</td>
<td>DNA-barcoding based identification of plant species from trace sample</td>
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<tr>
<td>8.</td>
<td>DNA isolation from hair and bone</td>
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</tbody>
</table>

This paper includes all the various types of instrumental techniques which can be employed in forensic examination. It comprises of various microscopic techniques, spectroscopic techniques like UV-Vis, FTIR spectrophotometer, Raman Spectroscopy AAS, Atomic Emission Spectroscopy, XRD, XRF, Chromatographic techniques like TLC, GC, LC, HPTLC etc.
UNIT-I


2. Electron microscopy: Principle and working of scanning electron microscopy (SEM), field emission scanning electron microscope (FE-SEM), transmission electron microscopy (TEM), Advantages/disadvantages as compared to optical microscopy and their forensic applications.

UNIT-II

1. Introduction to spectroscopy, electromagnetic spectrum, Method of Calibration and sample preparation, Atomic and Molecular Spectroscopy, Optical system used in spectroscopy, Limit of detection and Quantification.

2. UV-Vis spectroscopy, Fourier transforms infrared spectroscopy (FTIR), and Raman Spectroscopy: Their instrumentation, Analytical and Forensic applications, Near-Mid-Far ranges of spectroscopy, spectra of some common Organic molecules


UNIT-III

1. X-Ray Spectroscopy: X-ray Diffraction, X-ray Fluorescence; Origin of X-ray spectra, Instrumentation, differences between soft and hard X-rays, Analytical and Forensic Applications

2. Nuclear Magnetic Resonance (NMR): Basic principle, theory of Chemical Shifting, instrumentation, and Forensic applications


UNIT-IV


3. Mass Spectroscopy: Basic Principle, Instrumentation, applications, Ionization techniques i.e. Time of flight (ToF), Matrix-assisted laser desorption/ionization MALDI, Inductive coupled plasma (ICP).

Recommended Books


2. Instrumental Analysis- Skoog, Holler & Crouch, Cengage Lear

3. Instrumentation Methods of Analysis – Willard Merritt & Dean Settle


5. Introduction to spectroscopy, Donald L Pavia, Gary M. Lampman, and George S. Kriz, Cengage Learning-2015


1. To measure the various physical parameters of fiber samples using microscope
2. To find out the unknown concentration of the given sample using UV/Vis Spectrophotometer
3. To study the Beer’s Lambert’s law.
4. To study the Hypsochromic and Bathochromic shift using UV/Vis Spectrophotometer
5. To study the TLC of different inks of the writing pen.
6. To analyze the given compound using FTIR spectra
7. To analyse given sample by using Scanning Electron Microscope.
8. To perform the HPTLC of the given compounds
9. To analyze the XRD of given powder sample by using XRD software.
10. To analyze the given sample using XRF technique.

The realm of criminology takes up its scope and development, causes, control, criminal behavior and its theories. In criminal law the detailed description is provided regarding Indian penal code, criminal procedure code and the Indian evidence act. Forensic psychology includes the ethical issues, profile typing, psychological assessment, aspects of polygraph, brain signature profiling, hypnosis and related legal and ethical aspects. The evolutionary paradigm of psychology will be also studied in this paper.

UNIT-I

1. Criminology: Nature and Scope
2. Schools of criminology: Pre-classical, Classical, Neo-classical, Positive School

UNIT-II

1. I. Indian Penal Code
   (i) *Actus non facit reum nisi mens sitae rea*
   Elements of crime: *Actus reus & mensrea*
   (ii) Definitions: Dishonestly (S. 24), Fraudulently (S. 25), Good Faith (S. 52), Inquiry (S. 44), Voluntarily (S. 39), Reason to believe (S. 26)
   Criminal Liability : Joint liability (S. 34, 149)
   General Exceptions : Mistake of fact (S. 76, 79), Accident (S. 80)
   Unsoundness of mind (S. 84), Compulsion (S. 94)
<table>
<thead>
<tr>
<th>2.</th>
<th><strong>II. The criminal procedure code 1973</strong></th>
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</table>
| (i) | Definitions: Bailable and non-bailable offence (S. 2(a))  
      Cognizable offence 2(c), Complaint 2(d), Inquiry 2(g)  
      Investigation 2(h), Non Cognizable offence 2(l),  
      Summon case 2(w), Warrant case 2(x) |
| (ii) | Information in cognizable case: FIR (S. 154) |
| (iii) | Arrest of person without warrant and rights of arrested person (S.41 to 60 A) |
| (iv) | Process to compel appearance: (a) Summons (Section- 61,62,64,65,69)  
     (b) Warrant of arrest (Section-70 to 81) |
| (v) | Search and seizure (Sections- 93,100,101,102,165,167) |
| (vi) | Evidence of officers of Mint and Scientific Experts (Sections-292,293) |

<table>
<thead>
<tr>
<th>3.</th>
<th><strong>III. The Indian Evidence Act 1872</strong></th>
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</table>
| (i) | Definition: Section (3), Facts in issue, Evidence  
      Proved, Disproved, Not proved  
      May presume, Shall presume, Conclusive proof |
| (ii) | Examination of witness: Sections-135, 137, 141, 142, 143 |
| (iii) | Confession by accused: Sections-24, 25, 26, 30 |
| (iv) | Expert Evidence : Sections-45, 45-A, 46, 47, 47-A |

### UNIT-III

| 1 | Forensic Psychology and the Law |
| 2 | Ethical Issues in Forensic Psychology |
| 3 | Assessing mental competency |
| 4 | Psychological Assessment |
| 5 | Genetics and Crime |
| 6 | Introduction to Evolutionary Psychology |
| 7 | Social Organization, Aggression, and Mating in primates/Apes |
| 8 | Biological Constraints on Human Social Organization and Mating |
| 9 | Behavioral similarity and differences between human and apes |
| 10 | Examples of evolutionary adaptations in human behavior |

### UNIT-IV

| 1 | Detection of deception, Various methods for detection of deception |
| 2 | Non-verbal detection, voice stress analyzer, thermal imaging, functional magnetic resonance study |
| 3 | Current research in detection of deception/truth finding mechanisms |
| 4 | Principles of polygraph lie detection/truth verification |
| 5 | Psycho physiological aspects, operational aspects |
| 6 | Question formulation techniques, Interviewing technique procedure |
| 7 | Chart recording |
| 8 | The Art-Polygraph: Legal and Ethical aspects, Human rights of individual |
9. Principles of Brain Signature profiling, Nero psychological aspects, operational aspects, probe preparation, EEG-ER recording, analysis methodology and interpretation skills

10. Legal and Ethical aspects, Human rights of individual

11. Theory and validity of Hypnosis in forensic science

12. Narco analysis, General Procedure, Legal and Ethical aspects, Human rights of individual

**Recommended Books:**

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.Mukundan
5. Criminal Profiling – B.Turvey
7. Art & Science of the Polygraph Techniques – J.A.Matte
9. Detecting Lies & Deceit – A.Vrij

**Paper No.** | **Title**                     | **Marks**
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FSC-105 | Crime File/Scrap File | Total: 50

Crime file/Scrap file includes the collection recent and important forensically relevant cases published in newspapers/magazines/research journals. The collection should highlight the associated physical evidences and their forensic examination helpful in the case
2nd Semester

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<td>Molecular Biology</td>
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<td>Semester Exam: 80</td>
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<td>Internal Assessment: 20</td>
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This paper will be a melting pot of knowledge just like forensic science. It will bring together all the main streams of biology that hold a place of their own now. The knowledge imparted by these individual sciences will lead to a wholesome view of the biomolecules and their basic units along with an insight into forensic microbiology. In the coming times wars will not be fought with guns and tanks, they will be fought with strategies involving microbes. Thus who better than a forensic science student can fight such crime against humanity?

UNIT-I

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<tr>
<td>1</td>
<td>Chemistry of Nucleotides, Structure of DNA/RNA</td>
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<td>DNA Replication: Eukaryotic and Prokaryotic</td>
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<td>Helicases, Topoisomerases and other DNA replicating Enzymes</td>
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<td>3</td>
<td>DNA Denaturation, Cot-Rot curves,</td>
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<td>4</td>
<td>DNA Repair mechanisms</td>
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<td>DNA Epigenetics</td>
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<td>Eukaryotic and Prokaryotic Transcription.</td>
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<td>RNA Processing and Editing</td>
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<td>8</td>
<td>Protein synthesis and Gene Regulation</td>
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UNIT-II

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<td>Humoral and Cellular Immunology</td>
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<td>Structure and Functional Properties of Antibodies</td>
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<td>Production of Antibodies</td>
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<td>Diversity, Assembly, Switching and Maturation</td>
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<td>Complement System, Activation and Regulation</td>
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<td>Immune Response Disorders</td>
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UNIT-III

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<tr>
<td>1</td>
<td>Amino Acids, Proteins, Carbohydrates and Lipids: Structure and Functions</td>
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<td>Metabolism of essential Amino Acids and Urea Cycle, Denovo and Salvage pathway for Nucleotide Synthesis</td>
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<td>Bioenergetics, Glycolysis, Citric Acid Cycle, Oxidative Phosphorylation,</td>
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<td>Oxidation of Fatty acids,</td>
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<td>6</td>
<td>Hormonal Regulation</td>
</tr>
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UNIT-IV

<p>| | |</p>
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<tbody>
<tr>
<td>1</td>
<td>Introduction to Microbiology</td>
</tr>
<tr>
<td>2</td>
<td>Bacteria Structure and Function</td>
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<td>3</td>
<td>Viruses and Prions</td>
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<td>4</td>
<td>Eukaryotic pathogens</td>
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<tr>
<td>5</td>
<td>Fungi and Parasites</td>
</tr>
<tr>
<td>6</td>
<td>Microbial growth and Metabolism</td>
</tr>
</tbody>
</table>
Microbial genetics
Immunization, sterilization and disinfection
Fighting infections
Microbial Forensics: Applications in Bioterrorism, Building a national capacity to investigate Bioterrorism, Database for infectious microorganisms
Biocrimes, Microbial Forensics, and the Physician

Recommended Books
1. Molecular Biology of the Cell by Bruce Alberts et al. (Garland Science; 2nd edition)
2. GENES VII by Benjamin Lewin (Published by Jones and Bartlett Publishers)
3. Principles of Genetics by D. Peter Snustad, Michael J. Simmons, John B. Jenkins (Published by John Wiley & Sons)
4. Physical Biochemistry by David Freifelder (Published by W. H. Freeman and Company)
5. Molecular Biology by David Freifelder (Published by Jones & Bartlett Pub)
7. Biochemistry by Lubert Stryer (Published by W. H. Freeman and Company)
8. Basic Principles in Nucleic Acid Chemistry Vol I and II by Paul OPO Tso (Published by Academic Press)
10. Progress in Forensic Genetics 9: Proceedings from the 19th International ISFG Congress Held in Munster, Germany by Bernd Brinkmann and Angel (Published by Elsievers Health Sciences)
11. Human and Molecular Genetics by Peter Sudbery (Published by Pearson Education Limited)
12. An Introduction to Forensic Genetics by William Goodwin, Adrian Linacre, Sibte Hadi (Published by Wiley)
13. Human Variations by Stephen Molnar (Published by Prentice Hall)
14. Genomic Diversity: Applications in Human Population Genetics by Surinder Singh Papiha, Ranjan Deka, Ranajit (Published by Springer)
15. Basic Immunology: Author: Abul K. Abbas, Andrew H. Lichtman Publisher: WB Saunders; 2nd edition
16. Cellular and Molecular Immunology: Author: Abul K. Abbas, Andrew H. Lichtman Publisher: W.B. Saunders Company; 5th edition
17. Sourcebook in Forensic Serology, Immunology, and Biochemistry Author: R. E. Gaensslen Publisher: Natl Inst of Justice/Ncirs

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<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tr>
<td>FSC-201P</td>
<td>Molecular Biology Practical</td>
<td>Total: 50</td>
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<td>Semester Exam: 40</td>
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<td>Internal Assessment: 10</td>
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</tbody>
</table>

1. Detection, Isolation and Staining methods for different microorganisms of forensic application
2. Isolation of Plasmid DNA, Restriction enzyme digestion - ligation of plasmid
3. Study (observation) of some pathogenic Fungi and bacteria, (permanent slides)
4. Microbiological examination of water (Coli form test Microbiological examination of milk
5. Study of general Morphology and cultural characteristics of staphylococcus Streptococcus, Darmatophytes etc.
6. Study of normal flora of human body
7. Observation some spoiled food materials
8. Biochemical test for the identification of Soli bacteria (INVC test
9. Amino acid detections paper chromatography
10. Comparative evaluation of different methods of protein analysis, Lowry, Biuret, Kjeldahl,UV
11. Specific reactions for carbohydrates and estimation
12. Isolation of amino acids and proteins
13. Estimation of DNA and RNA

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<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>FSC-202T</td>
<td>Forensic Chemistry</td>
<td>Total: 100</td>
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<tr>
<td></td>
<td></td>
<td>Semester Exam: 80</td>
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<td>Internal Assessment: 20</td>
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</table>

This paper includes the basic concepts of forensic chemistry which are helpful in exploring the minute of the subject. It takes up the detective dyes, restoration of erased numbers, alcohols and it all related aspects, fire and arson, Indian standard specifications for the analysis of petroleum products. Analytical chemistry includes the basics of sampling and the analysis procedure

**UNIT-I**

1. Analysis of corrosive chemicals- acids and alkalies.
2. Examination of contact traces: Detective dyes: Bribery-definition under Indian penal code, Motives, Chemistry of detective dyes, Analysis
3. Restoration of erased numbers – Importance of numbers, Theory, Methods of marking of numbers on different surfaces
4. Obliteration and restoration of erased numbers on different surfaces

**UNIT-II**

1. Alcohol- Forensic significance, problems of prohibition, nature, production of different types of alcohols including wines, liquors, IMFS, rectified sprit and absolute alcohol
2. Proof spirit, Analysis of alcohol: Percentage of alcohol by specific gravity method, acidity, Methanol poisoning Breath-alcohol instrumentation, Interpretation and presentation of alcohol: Retrograde exploration or back calculation of alcohol concentration, Widmark's equation
3. Identifying the alcohol-impaired driver: Tests of impairment, Alcohol measurement (using blood, breath, urine, saliva and oral fluid)

**UNIT-III**

1. Arson – Definition under IPC, Nature of fire, Progress, Control, Burnt bodies, Seat and time of fire, Natural causes of fires, suspected arson, motives, person responsible
UNIT-IV

1. Analytical Chemistry (Toxicology): Overview, Sample collection, Preservation and Preparation
2. Analysis: Ionic equilibrium, pH scale, hydrolysis, solubility and ionic product.
3. Disposition: Absorption, Distribution, Excretion and Influencing Factors
4. Detection of drugs in alternative specimens: Hair, Oral fluids, Sweat

Recommended Books

2. Vogel’s Qualitative Inorganic Analysis (7th Edition) revised by G. Svehia (2nd Impression-2006).
5. The ISI Specification for Kerosene (IS: 1459/1974)
8. The Indian Standard Methods of Test for Petroleum Products IS:1448
9. Fire and Arson Investigation, J. Kennedy, Chicago (1962)
10. An Introduction to Forensic Science by Saferstein, R., 1976

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<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>FSC-202P</td>
<td>Forensic Chemistry</td>
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<tr>
<td></td>
<td>Practical</td>
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<td>Total: 50</td>
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<td></td>
<td>Semester Exam: 40</td>
<td></td>
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<tr>
<td></td>
<td>Internal Assessment: 10</td>
<td></td>
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</tbody>
</table>

1. Acids: (a) Analysis of individual acids (HCl, H$_2$SO$_4$ and HNO$_3$) (b) Mixture of acids (c) Effect on fabric and analysis
2. Chemical test and TLC of Phenolphthalein, Anthracene, Alta, Rhodamine B, Carbonate, Bicarbonate, Bleaching powder
3 Study of effect of different concentration of Sod. Carbonate, Sod. Bicarbonate, NaOH, Bleaching powder on Phenolphthalein

4 Collection of different bribery samples and extraction of Phenolphthalein (ether method)

5 Minimum detection limit of Phenolphthalein using TLC and UV method

6 Restoration of erased numbers of different surfaces

7 Identification of alcohol (ethanol, methanol) in given (a) known sample (b) unknown sample

8 Chemical analysis of alcohol for the presence or absence of all possible impurities

9 Analysis of various accelerants by GC (a) in pure form (b) after extraction from burnt cloth or soil

10 Determine the % proof of ethyl alcohol in (a) lab. fabricated sample (b) alcoholic beverages

11 Preparation of calibration curve for any drug/chemical and determination of concentration of unknown sample

12 Analysis of Petroleum products: Gasoline, Kerosene and Diesel (a) individually (b) in mixture, using TLC, UV-vis or GC

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**Paper No.** | **Title** | **Maximum Marks**
---|---|---
FSC-203T | Forensic Physics | Total: 100  
Semester Exam: 80  
Internal Assessment: 20

This paper includes basic principles of physics based techniques which can be applied to solve the various forensically relevant cases. It comprises of analysis of foot/footwear/Type impression, Tool marks, Paint Instrumental technique like IR, Py-GCMS, XRD etc., Fiber and Paint analysis, papers examination, soil and cement analysis, analysis of glass.

### UNIT-I


2. Tool Marks: Compression marks, Striated marks, Combination of compression and striated marks, Repetitive marks, Comparison of tool marks. Features: Class characteristics, Sub class characteristics, Individual characteristics, development of tool marks.

3. Paint: Microscopic examination, Micro chemical tests, Differential solubility and TLC, Infra-red spectroscopy, Pyrolysis Gas Chromatography, Mass Spectrometer, Elemental analysis of the pigments

### UNIT-II

1. Fiber: Fiber as Physical Evidence, fiber recovery, Fiber Identification: Physical matching, Microscopic Examination, solubility test, Chromatographic and Spectroscopic analysis (UV-Vis & FTIR) of Fibre.

2. Paper: Physical examination, Watermark Examination, Chemical Analysis, Analysis by FTIR.

### UNIT-III

1. Soil: Sample preparation, Removal of contamination, Microscopic Examination,
1. Particle Size Distribution, Ignition Test, Density distribution, pH Measurement, UV and TGA Analysis of soil.


3. X-Ray Powder Diffraction: Identification of adulterated cement and adulterant,

4. Mortar and Concrete: Analysis of mortar and concrete.

UNIT-IV


2. Physical parameters of glass: Fluorescence under UV radiation, Density or Specific gravity, Density measurements for bigger fragments of glass, Density comparison by flotation and density gradient tubes.

3. Refractive Index Measurement (RI): Glass refractive index measurement (GRIM), Immersion method, Becke line concept, RI using the mixture of miscible liquids and hot stage microscope, Elemental analysis, Glass fracture identification.

Recommended Books


Paper No. Title Maximum Marks
FSC-203P Forensic Physics Practical Total: 50
Semester Exam: 40
Internal Assessment: 10

1. Analysis of Radial, Concentric cracks in Glass fracture
2. Measurement of physical parameters (colour, density, refractive index) on glass samples
3. Calculation of unit cell parameters (a, b, c) and d values certain elements using Bragg’s law
4. Peak determination of Quartz, Beryl, Anthracite etc. stones using XRD
5. Development of footwear impressions.
6. Comparison of paint chips under microscope
7. FTIR analysis of paint samples
8. Microscopic examination of various fibres
9. Measurements of physical parameters of fibers (Number of strands, Diameter of strand, Dye marks, Twist, Colour, thickness)
10. Soil comparison using density gradient tubes
Quality management can be considered to have three main components: quality control, quality assurance and quality improvement. The paper covers up the scope and management of quality control and assurance, document control, internal audits and its technical requirements, sampling, role of assessor, assessor assignment procedure and processes of on site assessment.

Statistics is the science of making effective use of numerical data relating to groups of individuals or experiments. The paper takes up the concepts of probability, usage of SPSS, Bernoulli trials, scatter diagrams and the basic idea of significant tests.

UNIT-I

1. Scope, Quality, Quality Assurance, Quality Control
2. Management Requirements- organization, management system
3. Document control, Review of requests, Tenders and contracts
4. Subcontracting of tests and calibrations, Purchasing of services and supplies
5. Service to customer, Complaints and Improvement
6. Corrective action, Preventive action Control of records: Method of corrections in document
7. Management Review – Objectives, organization of management review, planning, implementation, records
8. Technical requirements – General, Personnel
9. Accommodation and environmental conditions, Tests and calibration methods and Analytical method validation
10. Equipment, Measurement traceability, Sampling, Sampling plan, Handling of test and calibration items
11. Assuring the quality of test and calibration results, Reporting the results
12. Good laboratory practices (GLP): Fundamental points, Resources, Raw data and data collection, SPOs
13. Good documentation
14. Lab safety

UNIT-II

1. Internal Audits, Terminology, Objectives, Organization of internal audits
2. Planning of audit, Implementation of internal audits, Follow up of corrective action
3. Records and reports of internal audits, Additional unscheduled audits
4. Assessor guide -Assessor’s role, Assessor assignment procedure
5. Procedure of assessment of new applicant laboratories, Pre-assessment visit
6. Guide of assessors to formulate recommendations for NABL
7. Procedure for conducting closing meeting

UNIT-III

1. Biostatistics: Meaning and objectives, Levels of measurements, nominal ordinal
| 1. | Linear correlation and regression. Standard error of estimate. Test of significance involving coefficients of linear correlation coefficient. |
| 2. | Testing of statistical hypothesis, Type I and Type II errors, Level of significance and critical region, Single sample tests involving means proportions. Two sample tests, difference between means and proportions. Student’s t-test, chi-square test and F-test. |

**Recommended Books**

1. NABL-113, Issue No.01 Issue Dt : 8.6.1998
2. IS/ISO/IEC 17025 : 2005 General Requirements for the competence of testing and calibration laboratories
3. NABL -161, Guide for Internal audit and Management Review for Laboratories
4. NABL-210, Assessor Guide Issue No.3, 1.5.2002
5. NABL-141, Guidelines for Estimation and Expression of Uncertainty in Measurement
11. Introduction to Bio-Statistics - Bancroft, Hildah
12. Categorical data Analysis - Alan Agreti
13. Biostatistics and Epidemiology: A Primer for Health and Biomedical Professionals - Sylvia Wassertheil-Smoller.
<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>FSC-204P</td>
<td>Quality Management and Statistics Practical</td>
<td>Total: 50&lt;br&gt;Semester Exam: 40&lt;br&gt;Internal Assessment: 10</td>
</tr>
</tbody>
</table>

1. SPSS practicals on computers: To cover those techniques of data preparation needed prior to data analyses, practical implementation of statistical analyses methods.

2. Practicals on ISO/IEC/17025: 205
Toxicology is the study of the adverse effects of chemicals precisely the poisons on living organisms. The paper comprises of characteristics and spectrum of exposure, metabolism of poison and the drugs, extraction viz. solvent extraction, solid phase extraction and isolation and analysis of various poisons.

Drug of abuse refers to a maladaptive pattern of use of a drug that is not considered dependent. The paper includes the definitions i.e. tolerance and addiction and effects of narcotics. Various drugs of abuse viz. opium, barbiturates, benzodiazepines, amphetamines and cannabis have been discussed including their characteristics and analysis.

UNIT-I

1 Toxicology-Concept and scope, Classification of poisons, Characteristics of exposure: Acute and chronic, Route, Site, Duration and Frequency
2 Spectrum of Toxic Effects, Dose-Response Relationship, Lethal dose: Methods,
3 Conflict Poisoning-Warfare Agents of Mass destruction
4 Extraction, Isolation and Identification of Poisons: Solvent Extraction – Stas Otto method, Ammonium sulphate method, Solid Phase Extraction, Clean-up Procedures, Metallic poisons: Identification and toxicology

UNIT-II

1 Pharmacokinetics and Metabolism: Types of Metabolic reactions
2 Drug Metabolism: phase I and II (Analgesics, Tranquilizers, Barbiturates and Benzodiazepines)
3 Pesticide Metabolism (intricacies): Herbicides, organophosphate insecticides, carbamates, Factors influencing Metabolism
4 Analysis: Scope, Screening and detection, Extraction: Homogenization, Enzymatic degradation, Extraction pathway for basic, acidic and neutral molecules (Drugs)

UNIT-III

1 Definition- Tolerance, Addiction, Use of Drugs, Withdrawal Symptoms.
2 Classification and Effects of Drugs, Synonyms, Diluents and Adulterants
3 NDPS Act, Drugs and Crime, Identification of Addict.
4 Opiates: Production of opium, Isolation of Morphine, Production of Heroin, Alkaloidal constituents of opium and heroin
5 Depressants (Barbiturates, Benzodiazepines, Methaqualone): Description of compounds, Production, Physical and chemical characteristics of derivatives, Analysis

1. Stimulants (Amphetamines, Cocaine): Description of compounds, Production, Physical and chemical characteristics of derivatives; Analysis
2. Hallucinogens (Cannabis, Ergot-LSD): Production, Description, Physical characteristics, Extraction, Chemical constituents.
UNIT-IV

**Recommended Books**

15. Vogel’s Qualitative Inorganic Analysis (7th Edition) revised by G. Svehia (2nd Impression-2006)

<table>
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<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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</table>
| FSC-301P  | Forensic Toxicology and Drugs of Abuse Practical | Total: 50  
Semester Exam: 40  
Internal Assessment: 10 |

1. Colour Tests  
(a) Drugs (Benzodiazepines, Barbiturates: Phenobarbital, Secobarbital,
Paracetamol, Diazepam, Lorazepam, Alprazolam etc.)  
(b) Pesticides (OPs Insecticides, Pesticides and Carbamates: (i) Malathion, chlorpyrifos, monocrotophos, dimethoate (ii) Lindane, DDT (iii) Propoxure, Seven)  
(c) Plant Poisons (Cannabis, Opiates, Calotropis, Dhatura, Ricimus etc.)  

2. TLC  
(a) Drugs (Benzodiazepines, Barbiturates: Phenobarbital, Secobarbital, Paracetamol, Diazepam, Lorazepam, Alprazolam etc.)  
(b) Pesticides (OPs Insecticides, Pesticides and Carbamates: (i) Malathion, chlorpyrifos, monocrotophos, dimethoate (ii) Lindane, DDT (iii) Propoxure, Seven)  
(c) Plant Poisons (Cannabis, Opiates, Calotropis, Dhatura, Ricimus etc.)  

3. Extraction of non-volatile organic poison from viscera by Solid-phase extraction (SPE) method  

4. Reinsch test for Metallic Poisons (Arsenic, Mercury, Antimony, and Bismuth)  

5. Microscopic identification Cannabis and analysis of alkaloids by Colour test (Dequenois Levine), TLC and UV-Visible Spectroscopy  

6. Detecting presence of Aluminum/Zinc phosphide in given exhibit  

7. Determination of Salicylate by visual colorimetry  

8. Analysis of plant poison plants (any of Datura, Calotropis, Ricimus) alkaloids by UV-Visible Spectroscopy  

9. Determining the quantity of OPs (any of Chlorpyrifos, Monochrotophos, Dimethoate) in unknown/suspect samples using UV-Visible technique  

10. Quantitative analysis of drugs (phenobarbital, paracetamol, Alprazolam, lorazepam) in unknown/suspect sample using UV-Visible technique  

<table>
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<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>FSC-302T</td>
<td>Ballistics</td>
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<td>Semester Exam: 80</td>
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<td>Internal Assessment: 20</td>
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</table>

Ballistics is the science of mechanics that deals with the flight, behavior, and effects of projectiles, especially bullets, gravity bombs, rockets etc. It also deals with the art of designing and accelerating projectiles so as to achieve a desired performance. This paper includes history of fire arms, ammunition, internal and external ballistics, terminal ballistics, fire arm examination, gunshot residue analysis and fire arm injuries.

**UNIT-I**

1. History of Firearms, classification and characteristics of firearms, components of small arm firearms, smooth bore and rifled firearm, bore and caliber, choke, different systems and their functions, Arms Act  

2. Purpose of rifling, types of rifling and methods of producing rifling, trigger and firing mechanism, Theory of recoil, identification of origin, improvised/ country-made/ imitative firearms and their constructional features  

3. Ammunition and their components, classification and constructional features of different types of cartridges, head stamp markings, various types of bullets and compositional aspects, latest trends in their manufacturing and design.  

4. Types of primers and priming composition, propellants and their compositions, Velocity and pressure characteristics under different conditions, Explosives Act

**UNIT-II**

1. Internal Ballistics: Definition, ignition of propellants, shape and size of propellants,
manner of burning, various factors affecting the internal ballistics: lock time, ignition time, barrel time, erosion, corrosion and gas cutting

| 2 | External Ballistics: Vacuum trajectory, effect of air resistance on trajectory, base drag, drop, drift, yaw, shape of projectile and stability, trajectory computation, ballistics coefficient and limiting velocity.
| 3 | Measurements of trajectory parameters, introduction to automated system of trajectory computation and automated management of ballistic data.
| 4 | Terminal Ballistics: Effect of projectile on hitting the target: function of bullet shape, striking velocity, striking angle and nature of target, Tumbling of bullets, effect of instability of bullet, effect of intermediate targets, influence of range, Ricochet and its effects, stopping power.

UNIT-III

| 1 | Principles of identification of firearms, different types of marks produced during firing process on cartridge-firing pin marks, breech face marks, chamber marks, extractor and ejector marks.
| 2 | Different types of marks produced during firing process on bullet, number of lands and grooves, direction of twist, depth of grooves and width of land/grooves, class and individual characteristics.
| 3 | Techniques for obtaining test material from various types of weapons, basic methodology used in comparison microscopy, linkage of fired bullets/cartridge cases with firearms.
| 4 | Automated examination and comparison of fired bullets/cartridge cases and ballistics imaging database of the markings of fired bullets/cartridge cases.
| 5 | Determination of range of fire/ bullet hole identification: Burning, scorching, blackening, tattooing and metal fouling, shots dispersion and GSR distribution, bullet hole identification, bullet penetration and trajectory through glass.

UNIT-IV

| 1 | Analysis of Gunshot Residues: Mechanism of formation of GSR, source and collection, spot test, chemical test, identification of shooter and instrumental methods of GSR Analysis, Management and reconstruction of crime scene; suicide, murder and accidental and self-defense cases.
| 2 | Firearm injuries: Threshold velocity for penetration of skin/flesh/bones, cavitations – temporary and permanent cavities, nature of wounds of entry, exit, bullet track with various ranges and velocities with various types of projectiles, explosive wounds.
| 3 | Evaluation of injuries caused due to shot-gun, rifle, handguns and country made firearms, methods of measurements of wound ballistics parameters, preparation of gel block penetration of projectiles in gel block and other targets, post-mortem and anti-mortem firearm injuries.

Recommended Books

This paper includes forensic anthropology, osteology and dentistry. It gives the students the strength of forming a picture with the information that they can retrieved from the bones- demography, race, sex, age etc. It also teaches them complete facial reconstruction and restoration. The facial superimposition and forensic art forms an intrinsic part of this science and of the syllabus here. This will ensure that the students of this paper will be of great help to the society and science as they will have hands on experience in the field. Ancient DNA typing along with procedures involved for optimization of these techniques is also a part of this paper.
<table>
<thead>
<tr>
<th>UNIT-I</th>
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<tbody>
<tr>
<td>1 Introduction to subject, Forensic anthropology, History, Scope and</td>
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<tr>
<td>methods, Introduction to forensic Archaeology</td>
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<tr>
<td>2 Investigation of death, determination of time since death and age</td>
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<tr>
<td>of the dead. Injuries: classification and type of injuries, nature</td>
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<td>of injuries – ante mortem/postmortem.</td>
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<td>3 Burn injuries due to fire, acid, crackers&amp; electricity. Mechanical</td>
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<td>Violence, fire arm injuries, blast &amp; projectile injuries, injuries</td>
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<td>in sexual offence, suicide &amp; homicide.</td>
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<td>4 Field and laboratory management of skeletal remains</td>
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<tr>
<td>5 Dental anatomy and forensic dentistry</td>
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<tr>
<th>UNIT-II</th>
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<tbody>
<tr>
<td>1 Introduction to subject of human osteology, its over-view, ethics</td>
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<td>and handling of bones. Anthropometric and osteometric variation in</td>
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<tr>
<td>human population</td>
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<td>2 Biological profiling of skeletal remains: Demography, sex, age,</td>
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<tr>
<td>stature and race estimation. Bio-distances and divergences</td>
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<tr>
<td>3 Trauma and Paleopathology as means of personal identity</td>
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<td>4 Micro-skeletal markers of activity and life history</td>
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<td>5 Body modifications and identification in living person</td>
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<td>6 Chemistry of bones</td>
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<tr>
<td>7 Time elapsed since death. Decomposition stages and forensic</td>
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<td>entomology</td>
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<td>8 Non metric skeletal variation</td>
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<th>UNIT-III</th>
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<tbody>
<tr>
<td>1 Forensic facial reconstruction Human facial anatomy including</td>
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<tr>
<td>bones and muscles, anatomy of the facial features, facial tissue</td>
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<tr>
<td>thicknesses with MRI and other methods, three dimensional method of</td>
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<td>facial reconstruction with clay method as well as with computerized</td>
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<tr>
<td>technique.</td>
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<tr>
<td>2 Facial restoration</td>
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<tr>
<td>3 Facial superimposition : Anthropological study of skull,</td>
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<tr>
<td>Photography of the skull in the same pose as the antemortem</td>
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<tr>
<td>photograph, enlargement of the antemortem photograph, comparison</td>
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<tr>
<td>of the facial features of the human skull and the antemortem</td>
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<tr>
<td>photograph. Still photographic method and computerized technique of</td>
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<tr>
<td>superimposition.</td>
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<tr>
<td>4 Forensic art: 2D facial reconstruction by drawing method from the</td>
</tr>
<tr>
<td>facial features, ‘rule of the thumb’ principles for facial</td>
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<tr>
<td>reconstruction, age progression on the face, relation.</td>
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<tr>
<th>UNIT-IV</th>
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<tbody>
<tr>
<td>1 Forensic anthropologists and mass disasters</td>
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<tr>
<td>2 Forensic Archaeology Introduction, Recovery of Forensic Evidence</td>
</tr>
<tr>
<td>from individual graves, Forensic Geophysical survey, Legal matters.</td>
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<tr>
<td>3 Molecular Anthropology: Progress and Perspectives</td>
</tr>
<tr>
<td>4 Genetic Anthropology, Human migrations, modern human ancestry,</td>
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<tr>
<td>Benefits and Controversies of Genetic Anthropology</td>
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<tr>
<td>5 Ancient DNA Typing: Introduction, Methods, strategies and</td>
</tr>
<tr>
<td>applications, Ancient DNA markers, CCR5, ΔF508, Ancient DNA extraction:</td>
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<tr>
<td>comparision of extraction methods, ancient DNA yield, ancient DNA</td>
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<tr>
<td>preservation, ancient DNA degradation patterns, the age of ancient</td>
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<tr>
<td>DNA, Fragment lengths of ancient DNA, storage of ancient DNA</td>
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<td>extracts.</td>
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### Recommended Books

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<tr>
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<tbody>
<tr>
<td>1.</td>
<td>Forensic Anthropology Laboratory manual Steven Byers and Susan, Myster, Allyn and Bacon Publishers</td>
</tr>
<tr>
<td>3.</td>
<td>The human bone manual Tim White and Pieter Folkens Academic press</td>
</tr>
<tr>
<td>4.</td>
<td>Forensic Archaeology: Advances in Theory and Practice by John Hunter, Margaret Cox (Routledge Taylor and Francis Group)</td>
</tr>
<tr>
<td>5.</td>
<td>Ancient DNA Typing: Methods, Strategies, and Applications by Susanne Hummel (Published by Springer)</td>
</tr>
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<td>7.</td>
<td>Anthropometry Singh, I.P. and Bhasin, M.K</td>
</tr>
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</table>

### Paper No. | Title | Maximum Marks |
|-------------|-------|---------------|
| FSC-303P    | Forensic Anthropology, Osteology and Odontology Practical | Total: 50  
Semester Exam: 40  
Internal Assessment: 10 |

1. Osteology: Human skeleton Axial and appendicular skeleton; Descriptive terminology used in osteology; Different classes of bones and their functions, features of bones; Bone identification, anatomical layout and skeletal recording
2. Visit to crematorium: Demonstration of bone injuries
3. Demonstration of bone and dental pathology
4. The Skull, Clavicle scapula and ribs, Vertebral column, Humerus radius ulna, Carpals metacarpals and phalanges, Pelvis, Femur tibia, fibula, patella, Tarsals, metatarsals, phalanges
5. Human and non human bones case study
6. Age and sex determination of Human skeleton
7. Osteometry, Scapula Measurements, angles, indices Humerus Measurements, Angles and indices Humerus and femur Torsion angles, Craniometry : Measurements on cranium and face
8. Somatometry : Landmarks on body; projective height measurements of the body in standing position measurements in sittingposition linear and breadth measurements of upper and lower extremities, Measurements of head and face; Indices.
9. Somatoscopy: Morphological observations of different body characters

### Paper No. | Title | Maximum Marks |
|-------------|-------|---------------|
| FSC-304T    | Cytogenetics | Total: 100  
Semester Exam: 80  
Internal Assessment: 20 |

This paper consists of basic genetics-blood grouping of various types, serum protein polymorphisms, Mendelian inheritance, mutations, genetic drift etc, human cytogenetics, mitosis, meiosis, DNA databanking, conservation genetics and statistics of forensic importance.
A study of this paper will be helpful in knowing the basics involved in the biology of DNA, proteins and blood (biological markers) along with their usage to arrive at forensically relevant information. This information is the key to the value attributed to the biological evidence when it is presented in the court of law.

**UNIT-I**

| 1. | Mendelian Inheritance |
| 2. | The concept of Genetics polymorphism |
| 3. | Blood groups: ABO, MN and Rh systems, ABH saliva secretion |
| 4. | Haemoglobin |
| 5. | Serum Proteins: Hptoglobin |
| 6. | Inborn errors of metabolism: Albinism, Phenylketonuria and Alkaptonuria PTC taste sensitivity and Glucose |
| 7. | Hardy-Weinberg Law |
| 8. | Mutations and Genetic Drift |
| 9. | Evolution, Molecular basis of Evolution |
| 10. | Natural Selection, Mutation |
| 11. | Genetic Segregation |
| 12. | Genetic Distance |
| 13. | Effects of Migration, |
| 14. | Marriages and Consanguinity |

**UNIT-II**

| 1. | General introduction Human Cytogenetics, Nomenclature Standardization in Human Cytogenetics |
| 2. | Mitosis Meiosis in Males, Meiosis in Females |
| 3. | Chromosome structure and cell division |
| 4. | Human somatic chromosomes, Morphological variability of human chromosomes |
| 5. | Heterochromatin and genetic inactivation: Heterochromatin, the sex chromatin, correlation between the number of chromatin masses and the number of X chromosomes. |
| 6. | Chromosome mutations in Man Numerical and structural changes |

**UNIT-III**

| 1. | Human Genome Project: Introduction, History, Goals |
| 2. | Benefits, Social, Ethical and Legal Issues |
| 3. | DNA Forensic Databases, Ethical, Legal, and Social Issues Associated with DNA Databanking, Potential Benefits of DNA Databanking |
| 5. | Genetic Discrimination, Behavioral genetics, Genetics and Violence |
UNIT-IV

1. Introduction to conservation genetics
2. Species or subspecies? Resolving taxonomic uncertainty
3. Wild populations, captive populations and conservation management units
4. Genetics and Reproduction, Cloning, Genetic selection
5. Using molecular biology for species preservation

Recommended Books

1. Population Genetics by John H Gillespie (Published by The Johns Hopkins University Press)
2. Progress in Forensic Genetics 9: Proceedings from the 19th International ISFG Congress Held in Munster, Germany by Bernd Brinkmann and Angel (Published by Elsievers Health Sciences)
3. Human and Molecular Genetics by Peter Sudbery (Published by Pearson Education Limited)
4. An Introduction to Forensic Genetics by William Goodwin, Adrian Linacre, Sibte Hadi (Published by Wiley)
5. Human Variations by Stephen Molnar (Published by Prentice Hall)
6. Genomic Diversity: Applications in Human Population Genetics by Surinder Singh Papiha, Ranjan Deka, Ranajit (Published by Springer)
7. Statistics at Square one by TDV Swinscow, Campbell, Kenneth L. Bontrager (Published by Hammicks BMA Medical Bookshop)
8. Forensic DNA Evidence Interpretation by John S. Buckleton, Simon J. Walsh (Published by CRC Press)
9. Statistics and the Evaluation of Evidence for Forensic Scientists by C. G. G. Aitken, Franco Taroni (Published by John Wiley and Sons)
10. Expert Evidence and Criminal Justice by Mike Redmayne (Published by Oxford University Press)
11. Interpreting DNA Evidence: Statistical Genetics for Forensic Scientists by Ian W. Evett, Bruce S. Weir (Published by Sinauer Associates)
14. Practical Cytology, applied Genetics and Biostatistics Goswami, H.K.
15. The Principles of Human Biochemical Genetics Harris, H.
17. Blood groups serology Boorman, Dodd and Lincoln
18. Human Genetics Mckusick, V.A
19. Principles of Genetics Stern, C.

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>FSC-304P</td>
<td>Cytogenetics Practical</td>
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Total: 50
Semester Exam: 40
Internal Assessment: 10

1. Analysis of Interphase Nuclei Introductory remarks
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<tr>
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<th>Procedure</th>
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<tr>
<td>2.</td>
<td>Buccal smears and blood smears obtaining the material, fixation, staining and scoring</td>
</tr>
<tr>
<td>3.</td>
<td>Chromosome painting/Florescent in situ hybridisation (FISH)</td>
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<td>4.</td>
<td>Slide test for sickle cell</td>
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<td>5.</td>
<td>Hb typing on paper electrophoresis</td>
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<td>6.</td>
<td>Test for G6PD enzyme deficiency</td>
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<td>7.</td>
<td>Starch agarose gel electrophoresis for Hb and G6PD systems</td>
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<tr>
<td>8.</td>
<td>Genetic Ratios : Segregation Ratios</td>
</tr>
<tr>
<td>9.</td>
<td>Identification of gender by amilogenin gene PCR</td>
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<td>10.</td>
<td>Test for PTC taste sensitivity</td>
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4th Semester

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<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tr>
<td>FSC-401T</td>
<td>Questioned Documents</td>
<td>Total: 100</td>
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<td></td>
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<td>Semester Exam: 80</td>
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<td>Internal Assessment: 20</td>
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Questioned document examination is the forensic science discipline pertaining to documents that are (or may be) in dispute in a court of law. The primary purpose of questioned/forensic document examination is to answer question about a disputed document using a variety of scientific processes and methods. The most common type of examination involves handwriting wherein the examiner tries to address concerns about potential authorship. This paper includes Nature and problems of document examination, basis of handwriting identification, identification of type writing, printing of security documents, and determination of age of document, e-document, digital signatures and opinion writing.

UNIT-I

2. Basis of handwriting identification – individuality of handwriting, natural variation, process of comparison,
4. Various writing features and their estimation, general characteristics of handwriting, individual characteristic of handwriting.
5. Basic tools needed for forensic documents examination and their uses.

UNIT-II

1. Disguised writing and anonymous letters
2. Identification of a writer, Examination of signatures – characteristics of genuine and forged signature,
3. Examination of alteration, erasers, overwriting, additions and obliterations,
4. Various types of inks and paper, their chemical compositions, characterization and elemental analysis
5. Decipherment of secret, indented and charred documents
6. Examination of seal impression and the mechanical impressions.

UNIT-III

1. Examination of black & white Xeroxed copies and colour Xeroxed copies, carbon copies, fax messages
2. Various types of forgeries and their detection
3. Examination built up documents – determination of sequence of strokes by microscopic examination.
4. Physical matching of documents
5. Identification of type writings – Identification of typist, Identification of printed matter
6. Various types of printing of security documents, printing of currency notes, latest security feature of new Indian currency note of Rs 500 & Rs 2000,
examination of counterfeit currency notes, passports, visa, stamp papers, postal stamps.

UNIT-IV

1. Determination of age of documents by examination of signatures – paper ink and writing/signatures etc., by spectroscopic and chromatographic methods and statistical technique.

2. Examination of computer print out, identification of dot-matrix, ink-jet and laser printers, electronic typewriter, e-documents, digital signatures

**Recommended Books**


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<tr>
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<tr>
<td>FSC-401P</td>
<td>Questioned Documents Practical</td>
<td>Total: 50 Semester Exam: 40 Internal Assessment: 10</td>
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</tbody>
</table>

1. Sequence of different colour strokes
2. Ink Differentiation by UV-Vis & FTIR spectrophotometer
3. Identification of individual and class characteristics of a writer from five writings
4. Display of characteristic features of forgery in a document
5. Identification of movements, speed, form of letters in a piece of writing
6. Dating of Ink by using FTIR analysis
7. Display of type writings with its elements of analysis i.e. letter design, vertical and horizontal alignments, wear and tear marks
8. Identification of alteration, addition, and subtraction in a piece of writing
10. Examination of counterfeit currency by using microscopy and UV light
**UNIT-I**

1. Principles of Computer: Memory and processor, address and data buses, stored program concept. Basic electrical safety, Motherboards, Start of boot sequence, Power on Self Test (POST), BIOS and CMOS, MSDOS, Windows 95/98/ME, Windows NT/2000/XP and Mac operating systems.

2. Methods of storing data: number systems, character codes, record structures, file formats and file signatures. Word processing and graphic file formats.

3. Hardware: Development of the hard disk, Physical construction, CHS and LBA addressing, Encoding methods and formats, IDE and ATA specifications, overcoming the 528 MB, 8 GB and 127 GB limitations, Dynamic drive overlays. Boot sector, partition table, slack space and free space, Disk mapping.

**UNIT-II**

1. The logical structures of the Microsoft operating system FAT file system. The DOS and Windows boot process. How to recover deleted files. The significance and determination of the creation date and time. Passwords and encryption techniques: Importance of keeping a log, Explanation of passwords keys and hashes.

2. Seizure of computers: Preparations to be made before seizure, Actions at the scene, Treatment of exhibits. How to make bitstream (exact copies) of the original media.

3. Investigation: Investigating on various imaging methods. Lay down the image provided onto a hard disk and provide a disk map of the suspect drive. Extraction of all relevant information from a hard disk.

4. Instruction on the acquisition, collection and seizure of magnetic media. How to best acquire, collect or seize the various operating systems. Legal and privacy issues.

5. Forensic examination procedures. Preparing and verifying forensically sterile storage media.

**UNIT-III**

1. Definition and types of Cyber crimes

2. HTML and other Internet protocols, Internet History and Topology, Internet Services and Access, Internet Protocols and Addressing, E-Mail and Header Interpretation, E-Mail Attachments, FTP, Telnet and IRC, Internet Chat, HTTP.
UNIT-IV

1. Overview of several operating systems including:
   Windows NT/2000/XP, Linux, DOS, Windows 95/98

2. Registries: Use of registry viewers, use of Regedit and WinHex; Typed URLs;
   understanding of User Assist; Mounted Devices, Event Log; extracting USB
   related artifacts; understanding and examination of protected storage.

   Accessing devices, partitions, and file systems. Using a desktop (GUI)
   environment, and introducing common desktop applications. The shell and
   common command-line utilities, Understanding Linux Kernels, distributions,
   graphical environments and available options, Installing and configuring
   Linux and Linux applications.

S.No. | Recommended Books
--- | ---
2. | Computer crime-A crime fighter’s hand book, David Icove, K. Seger and
   W.Vonstorch, O’reily & Alseriates, Inc.
3. | Digital evidence and computer crime-Forensic science, computers and the
   internet, Casey, Academic press.
4. | Computer forensics-Computer crime scene investigation, John R. Vacca,
   Firewall Media, New Delhi.
5. | Computer evidence-Collection and preservation, Christopher L.T. Brown,
   FireWall Media, New Delhi.
6. | Cyber forensics-A field manual for collecting, examining and preserving of
   computer crimes, A.J. Marcella, Robert S. Greenfield, Auerbach publications.
7. | Cyber crime, Doughless Thomas and Brian D.Loader.
8. | Cyber crime, Doughless Thomas and Brian D.Loader.
    G.Heiser., Addison Wesley.
11. | Cyber crime investigation field guide, Bruce Middleton, Auerbach
    publications.

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<tr>
<th>Paper No.</th>
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<td>FSC-402P</td>
<td>Computer Forensics Practical</td>
<td>Total: 50</td>
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<td>Semester Exam: 40</td>
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<td>Internal Assessment: 10</td>
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</table>

1. Detailed analysis of FAT 12, FAT 16, FAT 32 and NTFS file systems.
2. Practical exercises in dismantling and re-building PCs.
3. Practical recovery of such data using methods to preserve its integrity. Methods
   of recovering deleted files. Copying and imaging
4. Methods of hiding data on hard and floppy disks
5. A series of practical lab exercises designed to demonstrate how to access forensic artifacts within hard disk drives and to develop the student's skills in forensic analysis.

6. Finding and documenting data and files in unallocated space.

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<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Maximum Marks</th>
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<tr>
<td>FSC-403T</td>
<td>Advanced DNA Methods</td>
<td>Total: 100</td>
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<td>Semester Exam: 80</td>
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DNA technology is the latest and most powerful technique used in forensic biology at the moment with new additions nearly every few weeks. Therefore, this paper is designed to make the students well equipped with the DNA technology used with reference to forensic science. It includes both the chromosomal and extra chromosomal DNA with the markers of interest to forensics, extraction and amplification procedures with emphasis on PCR, sequencing and STR analysis, latest NGS technique of DNA and its forensic applications. There is summarization of bioinformatics which touches upon the phylogenetics, and human genetic disorders.

UNIT-I

1. Introduction, Methods, strategies and applications DNA markers
2. Mitochondrial, DNA the hypervariable regions and control regionV
3. Biology of STRs, Forensic Issues
4. Chromosomal DNA Amelogenin, Autosomal STRs, Y Chromosomal STRs, X chromosomal STRs
5. Variable Number Tandem Repeat (VNTR’s) and RFLP
6. Single Nucleotide Polymorphism (SNP’s)

UNIT-II

1. DNA Extraction, Organic and Inorganic extraction, Comparison of Extraction methods, Commercial kits
2. DNA Quantitation, Importance of quantitation, Spectrophotometric analysis, Agarose Gel Electrophoresis, Slot Blot Hybridization, Real Time PCR
3. Polymerase Chain Reaction
4. Basic PCR mechanism, Real time PCR, Primer designing
5. Primer dimmer and Hairpins, Mismatch primers
6. Software’s packages, Multiplex PCR, PCR failures
7. DNA degradation, Inhibition, DNA overload and Cycling

UNIT-III

1. NGS (next generation sequencing techniques of DNA): principles
2. Protocols in NGS
3. Application of NGS in forensics
UNIT-IV

1. Eukaryotic genome structure and concepts of genomic analysis
2. Public sequence databases: DNA, RNA, proteins, whole genomes
3. Data mining for homologous sequences
4. Multiple sequence alignment algorithms
5. Phylogenetic trees and molecular evolution
6. Microarrays and transcriptome analysis
7. The proteome, metabolome, glycome, lipidome, and interactome
8. Human genes and genetic disorders
9. Ethics in human bioinformatics and genomics
10. Y Chromosome testing
11. Non-Human, medical, and research applications

**Recommended Books**

10. Forensic DNA Typing Protocols
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<tr>
<td>FSC-403P</td>
<td>Advanced DNA Methods Practical</td>
<td>Total: 50</td>
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1. DNA Isolation, STR PCR
2. Post PCR sample preparation
3. Searching Barcode database for identification of insects
4. Differential extraction of DNA from bull semen and vaginal epithelial cells
5. STR Analysis, Genescan, Genotyper, Genemapper
6. mtDNA: Sample collection, extraction
7. Polymerase Chain Reaction, Contamination Control
8. Gel purification of PCR Product
9. BigDye Sequencing PCR
10. PCR cleanup, Set up, Sample loading Sequencing on Genetic Analyzer
11. Sequence analysis, BLAST Search, troubleshooting
12. Independent sequencing projects, practice on analysis of STR profiles of mixed sample degraded sample and identification of STR artifacts
An explosive is a substance that contains a great amount of stored energy that can produce a sudden expansion of the material after initiation, usually accompanied by the production of light, heat, sound, and pressure. This paper covers up all the essentials of different explosive material and further includes the explosive devices, assessment of properties, effects of explosives, assessment of damage, explosive detection and laboratory examination of post blast debris.

**UNIT-I**

1. History of Explosives (Milestones)
2. Explosive and explosion: Definition, Components, Theory of explosion: deflagration, detonation, mechanism
3. Classification: Inorganic and Organic, Condensed and Dispersed, Deflagrating and Detonating, Low and High (Chemistry and synthesis, illustrated), Primary and Secondary
5. Non-explosive explosions: Mechanical, Thermal, Electrical, Aerosol

**UNIT-II**

1. Pyrotechniques: Basics and chemistry
   Improvised Explosive devices (IEDs): Basics, Initiation, Mechanism, Types
2. Properties of explosives: Strength or power of explosives, Brisance, Sensitivity or specificity of explosives, Relative effectiveness factor, Stability, Density, Volatility, Hygroscopicity, Oxygen balance, Toxicity, Melt cast
3. Shock wave/blast wave: Generation of the shock wave, Characteristic, Effect of mach reflections, Effect of confinement, Channelling of blast wave
4. Explosion effects-types: Blast pressure: Positive and Negative, Thermal, Fragmentation, Ancillary
5. Physics of explosion hazards; Thermo-chemistry of explosives, The Explosion process, Types of hazard

**UNIT-III**

1. Blast injuries:
   Primary- (Direct) blast wave exposure
   Secondary- Blast energized bomb fragments and other debris (shrapnel)
   Tertiary- Abrupt deceleration of the body- indirect blast wave effect
   Quaternary- Collapse of building
2. Assessment of Damage: Importance, Value to be attached to damage observations, Importance of the Site of the Explosion centre, Significance of Pressures, Fragmentation: Information from fragments
   Explosion site – Location; Scene of explosion - Planning
3. Laboratory examination of Post Blast Debris: Physical examination,
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<td>4.</td>
<td>Comprehensive laboratory examination of Explosive Substances: Recovery and clean-up, Chemical tests: Acidic and basic radicals, Color tests and TLC</td>
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<td>5.</td>
<td>Crime investigation related to explosions: Laboratory capabilities, Reading the Bomber’s signatures (case study)</td>
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**UNIT-IV**

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| 1. | Explosive Detection : Issues, Threats and Problems  
   (i) Trace/Vapor Detection: Trained Animals, GC-ECD (adsorption and pre-concentration)  
   Ion mobility spectrometry (IMS), Bio/Chemiluminescence |
| 2. | (ii) Bulk Detection: X-ray imaging, Backscatter imaging  
   Detection with energetic protons, Thermal neutron activation (TNA), Fast neutron analysis (FNA) |
| 3. | Taggants-Tagging of Explosives |
| 4. | Analysis and detection of explosives by Mass Spectrometry: RDX TNT |

**Recommended Books:**


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<tr>
<th>Paper No.</th>
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<tr>
<td>FSC-404P</td>
<td>Forensic Explosives Practical</td>
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<td>Total: 50</td>
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<td>Semester Exam: 40</td>
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<td>Internal Assessment: 10</td>
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1. Ion analysis of (i) Standard radicals and (ii) Radicals from explosive debris
2. Analysis of lab fabricated explosive samples
3. Chemical tests for mixtures of anions
4. Analysis and color test for Nitrate explosives and Black powder
5. TLC of RDX, TNT, NG and PETN
6. Analysis of Pyrotechnique mixtures
7. Analysis of components of crackers

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<tr>
<td>FSC-405T</td>
<td>Forensic Audio-Video Analysis</td>
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<td>Total: 100</td>
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<td>Semester Exam: 80</td>
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Forensic Audio Video analysis is the scientific examination, comparison and/or evaluation of audio-video in legal matters. This paper includes Audio Level measurement; noise characteristics sound recording play back devices, authentication of recorded audio, introduction to video technology component of Digital Image processing, Image enhancement, restoration, Forensic analysis of audio/Video in Video recording Basic Factors of sound in speech, Acoustic speech production, Phonetic aspects of speech speaker identification etc.

**UNIT-I**

1. Audio Level Measurement: Voltage, Decibels, Audio line levels, Frequency measurements, range, Spectrum Analysis, Basic Electric Circuits
3. Sound Recording/Playback Devices: Analog Tape recorders, Digital recorder,

UNIT-II
1. Introduction to Video technology: Video standards, Recording formats- Analog and Digital, Introduction to Video devices, Linear and Non-linear Editing, Concept of Video film Production, Graphics and animation technique.

UNIT-III

UNIT-IV
3. Introduction to Pattern recognition Application in Automatic Speaker Identification and Verification System.
4. Legal status in India and Abroad: Historical Background on Speaker Identification in USA, European countries and India. Judgment of Supreme Court of India on
report of Speaker Identification. Court presentation of report based on speaker Identification. Ear witness-Speaker Profiling, Speaker Line-up.

**Recommended Books**

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<tr>
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<th>Title</th>
<th>Publisher, Location</th>
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<tbody>
<tr>
<td>4</td>
<td>Speech Sounds, Patricia Ashby, Routledge, London and New York</td>
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<tr>
<td>6</td>
<td>Digital Audio Restoration, Simon J. Godsill and Peter J.W. Rayner, Springer</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>A Laboratory Manual on Bilogical Anthropology and Anthropometry, Indera P. Singh and M.K. Bhasin, Kamla-Raj Enterprises, 2273, Delhi</td>
<td></td>
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<tr>
<td>9</td>
<td>Forensic Uses of Digital Imaging, John C. Russ, CRC Press</td>
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<tr>
<td>10</td>
<td>A Simplified Approach to Image Processing, Randy Crane, Prentice Hall PTR New Jersey.</td>
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**Paper No.** FSC-405P

<table>
<thead>
<tr>
<th>Title</th>
<th>Maximum Marks</th>
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</table>
| Forensic Audio-Video Analysis Practical | Total: 50  
Semester Exam: 40  
Internal Assessment: 10 |

1. Recording the voice of a speaker using a tape recorder and measures for keeping it in the safe custody.
2. Making a working copy of the recording in appropriate format in analog mode.
3. Recording the speech sample of a speaker using digital audio tape recorder.
4. Measures to be taken care during recording the specimen speech sample of a suspect.
5. Digitization of analog speech sample.
7. Transcription of speech sample using IPA symbols.
8. Selection of verbatim for speaker identification.
9. Extraction of audio from a video recording.
10. Anthropometric measurements in facial recognition from a still image/photograph.
INSTRUCTION FOR EXAMINERS FOR THEORY PAPERS:

1. For the semester examination a total of nine questions will be set, two from each of the Units I, II, III and IV. There will be one compulsory question of eight to ten short answer type questions covering the whole syllabus. There will be no choice in the compulsory question.

2. Students will be required to attempt five questions choosing one question from each of the Units I, II, III, IV and the compulsory question.

3. All questions will carry equal marks.