GENERAL INSTRUCTIONS
&
COURSE WORK CURRICULUM

FOR

(Ph. D. Forensic Science)
(Effective from November 2024)

DEPARTMENT OF FORENSIC SCIENCE
HIMACHAL PRADESH UNIVERSITY
(NAAC Accredited "A" Grade University)
SUMMERHILL, SHIMLA-171005 (HP)-India.
www.hpuniv.ac.in/forensic

Outline of the Course Work for Ph.D. in Forensic Science

Code	Title of Paper	Max. Marks	Credit Weightage
RPE-PhD	Research and Publication Ethics (*Common for all HPU's Ph.D. programs*)	50	2 Credits
PhDFS-101	Research Methodology (**Compulsory**)	100	5 Credits
Elective: Any one of the following, i.e., PhDFS-EL-102 (i-v)		100	5 Credits
PhDFS-EL-102 (i)	Forensic Biology, Serology & DNA Profiling	100	5 Credits
PhDFS-EL-102 (ii)	Forensic Chemistry & Toxicology	100	5 Credits
PhDFS-EL-102 (iii)	Digital & Cyber Forensics and IT Security	100	5 Credits
PhDFS-EL-102 (iv)	Questioned Documents, Fingerprints and Biometrics	100	5 Credits
PhD FS-EL-102 (v)	Forensic Physics and Ballistics	100	5 Credits
Total Credits/ Marks		250	12

Note: Ph.D. course work classes will be held in afternoon session. Students with 75% attendance will be eligible for the final written examination. The passing marks for PhD coursework will be 55% aggregate, with minimum 50% in each individual course (All three courses). The examination will be conducted for three-hour duration.

INSTRUCTIONS FOR THE PAPER SETTER

RPE-PhD *paper will carry 50 marks, while* **PhDFS-101** *and* **PhDFS-EL-102 (i-v)** *will carry 100 marks each. The duration of all these exams will be three hours.*

For RPE-PhD*, there will be 7 questions covering all the units. The first six questions (1, 2, 3, 4, 5, & 6) of 6 marks each will consist of one question from each unit, with an internal choice provided, meaning there will be two questions from each unit. The 7th question will consist of 10 short-answer-type questions using Roman numerals (i, ii, iii... x), each with 2 marks. There will be at least one question from each unit, and students will be required to attempt any seven out of ten.*

For PhDFS-101 *and* ***PhDFS-EL-102 (i-v)****, there will be 11 questions covering all the units. The first 10 questions of explanatory answers (1, 2, 3...10) of 12 marks each will consist of one question from each unit, with internal choice provided, meaning there will be two questions from each unit ($5\times2=10$). The students will be required to attempt one question from each unit. The 11th question will consist of 10 short-answer type questions, using Roman numerals (i, ii, iii... x), each with 5 marks, covering all the units. The students will be required to attempt any eight questions out of the ten.*

RPE-PhD: Research and Publication Ethics

(Common for all HPU's Ph.D. Programs)

Max. Marks: 50

Credit Weightage: 2

Total Teaching Hours: 30

Syllabus for Research and Publication Ethics in Forensic Science

Course Description: This course consists of six units focusing on the fundamentals of the philosophy of science and ethics, research integrity, and publication ethics. Hands-on sessions are designed to identify research misconduct and predatory publications. The course will also cover indexing and citation databases, open-access publications, research metrics (such as citations, h-index, and Impact Factor), and plagiarism detection tools.

Objectives:

➢ Promote the importance of research integrity.
➢ Discuss the principles of publication ethics.
➢ Educate on identifying research misconduct and predatory publishing.
➢ Explain indexing and citation databases.
➢ Provide information on open-access publications and research metrics.
➢ Introduce various plagiarism detection tools.

Course Outcomes:

1. Knowledge Outcomes:

At the end of the course, students will possess

- Gain comprehensive knowledge of research integrity, ethical publishing, and misconduct prevention.
- Understand best practices, standard-setting guidelines, and ethical considerations in publishing.
- Explore open-access initiatives, citation databases, and journal impact metrics.
- Learn to use plagiarism detection tools and evaluate research quality through indexing and accreditation.

2. Skill Outcomes:

At the end of the course, students will possess:

- Develop the ability to conduct research with integrity and adhere to ethical guidelines.
- Enhance skills in writing, reviewing, and publishing research papers following ethical standards.
- Gain proficiency in using software tools to identify and prevent research misconduct.
- Acquire skills to evaluate research quality using citation databases and research metrics.
- Strengthen the ability to identify and address ethical issues in scientific publishing.

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Department of Forensic Scienc
Himachal Pradesh University
Shimla-171005 HP
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Unit-I: Philosophy and Ethics

- Introduction to Philosophy: Definition, nature, scope, concept, and branches.
- Ethics: Definition, moral philosophy, nature of moral judgments and reactions.

Unit-II: Scientific Conduct

- Ethics in science and research.
- Intellectual honesty and research integrity.
- Scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP).
- Redundant publications: Duplicate and overlapping publications, salami slicing.
- Selective reporting and misrepresentation of data.

Unit-III: Publication Ethics

- Publication ethics: Definition, introduction, and importance.
- Best practices and standard-setting initiatives: COPE, WAME, etc.
- Conflicts of interest.
- Publication misconduct: Definition, concept, and causes of unethical behaviour
- Violations of publication ethics: Issues related to authorship and contributor-ship.
- Identification of publication misconduct, handling complaints, and appeals.
- Predatory publishers and journals.

Unit-IV: Open Access Publishing

- Open-access publications and initiatives.
- SHERPA/RoMEO online resource for publisher copyright & self-archiving policies.
- Software tools to identify predatory publications (developed by SPPU).
- Journal finder/journal suggestion tools (e.g., JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.).

Unit-V: Publication Misconduct

A. Group Discussions
- Subject-specific ethical issues, FFP, and authorship.
- Conflicts of interest.
- Complaints and appeals: Examples of fraud from India and abroad.

B. Software Tools
- Use of plagiarism detection software such as Turnitin, Urkund, and other open-source tools.

Unit-VI:Databases and Research Metrics

A. Databases
- Indexing databases.
- Citation databases: Web of Science, Scopus, etc.

B. Research Metrics
- Journal impact factor as per Journal Citation Reports (JCR), SNIP, SJR, IPP, CiteScore.
- Author-level metrics: h-index, g-index, i10-index, Altimetric.

Suggested readings:

1. Beall, J. (2012). *Predatory Publishers are Corrupting Open Access. Nature*, 489(7415), 179. https://doi.org/10.1038/489179a
2. Bird, A. (2006). *Philosophy of Science* (1st ed.). Taylor & Francis. ISBN: 978-0203133972.
3. Bretag, T. (2016). *The Handbook of Academic Integrity* (1st ed., Vol. 1). Springer. ISBN: 978-981-287-097-1.
4. Chaddah, P. (2018). *Ethics in Competitive Research: Do Not Get Scooped, Do Not Get Plagiarized*. Self-Published. ISBN: 978-9387480865.
5. Grudniewicz, A., Moher, D., Cobey, K. D., & 32 authors. (2019). *Predatory Journals: No Definition, No Defense.Nature*, 576(7786), 210-212. https://doi.org/10.1038/d41586-019-03759-y
6. Ghosh, A., Singhvi, A. K., & Muralidhar, K. (2019). *Ethics in Science Education, Research, and Governance* (1st ed.). Indian National Science Academy. ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf
7. Israel, M., & Hay, I. (2006). *Research Ethics for Social Scientists* (1st ed.). SAGE. ISBN: 978-0761947735.
8. Lang, J. M. (2013). *Cheating Lessons: Learning from Academic Dishonesty*. Harvard University Press. ISBN: 978-0674724631.
9. MacIntyre, A. (1967). *A Short History of Ethics*. Touchstone. ISBN: 978-0023639602.
10. National Academy of Sciences, National Academy of Engineering, & Institute of Medicine. (2009). *On Being a Scientist: A Guide to Responsible Conduct in Research* (3rd ed.). National Academies Press. ISBN: 978-0309119702.

PhDFS-101: Research Methodology
(Compulsory)

Max. Marks: 100

Credit: 5

Total Teaching Hours: 75

Syllabus for Research Methodology

Course Description:

This course provides a comprehensive understanding of research methodologies, data collection, statistical analysis, and scientific writing in forensic science. It covers fundamental aspects of research, including problem formulation, hypothesis testing, sampling techniques, and statistical tools for data interpretation. Emphasis is placed on ethical considerations, forensic research writing, and quality management standards such as ISO and NABL accreditation. Additionally, the course introduces students to the concepts of patents and intellectual property rights (IPR), including patent filing processes and legal frameworks in India. The course equips students with essential skills for conducting high-quality research, preparing scientific reports, ensuring compliance with forensic laboratory standards, and understanding the role of patents in scientific innovation.

Objectives:

- Equip students with the fundamental principles and methodologies of scientific research.
- Provide knowledge of statistical tools and techniques for effective data analysis.
- Educate on research integrity, publication ethics, and responsible conduct in research.
- Train students in writing research proposals, thesis reports, patent applications, and scientific publications
- Familiarize students with ISO, NABL, and quality management systems in forensic science.

Course Outcomes:
1. Knowledge Outcomes:
At the end of the course, students will:

- Gain a comprehensive understanding of research principles, methodologies, and significance.
- Develop skills in sampling techniques, statistical tools, and data interpretation.
- Learn to write research proposals, reports, patent applications, and maintain academic integrity.
- Utilize parametric and non-parametric tests for hypothesis testing and data analysis.
- Understand ISO, NABL accreditation, quality audits, and good laboratory practices.

2. Skill Outcomes:

At the end of the course, students will:

- Develop the ability to define research problems, design studies, and analyze data effectively.
- Gain expertise in applying descriptive and inferential statistical techniques for data interpretation.
- Enhance skills in writing research proposals, reports, patent applications, and scientific papers with clarity and precision.
- Understand research ethics, accreditation processes, and quality management systems in forensic science.
- Improve critical thinking and decision-making skills in research methodologies and forensic application.

Course Content:

Unit-1: Introduction to Research

- Research: Meaning, Objectives, Types, Approaches, and Significance
- Defining the Research Problem & Research Design
- Variables, Sources of Problems, Title, and Objectives Writing
- Testing of Hypothesis (Parametric & Nonparametric), Limitations

Unit-II: Sampling and Data Collection

- Sampling Design: Implications, Steps, Criteria, and Characteristics
- Sampling: Need, Sample Size Determination, and Procedures
- Sampling Errors
- Methods of Data Collection: Primary & Secondary Sources, Observation, Interview, Questionnaires, and Schedules

Unit-III: Data Analysis and Statistical Tools

- Analysis of Data
- Statistics in Research
- Descriptive & Inferential Statistics:Measures of Central Tendency; Dispersion; Asymmetry (Skewness); Correlation and Regression Analysis.
- Statistical Tests:Chi-Square Test; t-Test; z-Test; F-Test; U-Test; ANOVA, ANCOVA

Unit-IV: Research Writing and Ethics

- Writing of Thesis and Research Reports

- Writing Research Proposals & Papers: Types
- Editing and Evaluating Drafts for Organizing Conferences and Funding Agencies
- Patent or Intellectual Property Rights (IPR): Concept, Types of Patents, Patent Filing Process, Patentability Criteria, and Patent Laws in India.
- Ethical Considerations in Forensic Science

Unit-V: Accreditation and Quality Management

- Accreditation: ISO & NABL-History, Development, and Functions
- Quality Management System
- Quality Audit
- Good Laboratory Practices

Suggested readings:

1. ISO/IEC 17025:1999(E) (1999)-*International Standard on General Requirements for the Competence of Testing and Calibration Laboratories*, 1st Edition, International Organization for Standardization. ISBN: Not Applicable.
2. Kothari, C.R. (2004)-*Research Methodology: Methods and Techniques*, New Age International Publishers, New Delhi. ISBN: 978-8122415223.
3. Saferstein, R. (2002)-*Forensic Science Handbook (Vol. I, II, III)*, Pearson Prentice Hall. ISBNs: 978-0130921410 (Vol. I), 978-0131124346 (Vol. II), 978-0131124339 (Vol. III).
4. St. Clair, Jami (2003)-*Crime Laboratory Management*, Academic Press. ISBN: 978-0126640517.
5. Thomas, A. (1992)-*The Laboratory Quality Assurance System: A Manual of Quality Procedures and Forms*, CRC Press. ISBN: 978-0849343985.
6. Clark, Gary B. (1996)-*Systematic Quality Management: Practical Laboratory Management Series*, Wiley-Interscience. ISBN: 978-0471122045.
7. Chaddah, P. (2018)-*Ethics in Competitive Research: Do Not Get Scooped; Do Not Get Plagiarized*, Indian National Science Academy. ISBN: 978-9387480865.
8. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009)-*On Being a Scientist: A Guide to Responsible Conduct in Research*, Third Edition, National Academies Press. ISBN: 978-0309119702.
9. Duncan, William L. (1986)-*Total Quality: Key Terms and Concepts*, Free Press. ISBN: 978-0029077014.
10. Sansawal, D.N. (2008)-*Research Methodology and Applied Statistics*, S. Chand Publishing, New Delhi. ISBN: 978-8121911398.
11. Houck, Max M. (Ed.) (2022)- *Encyclopedia of Forensic Sciences*, 3rd Edition, Elsevier. ISBN: 978-0128236772

PhDFS-EL-102 (i): Forensic Biology, Serology & DNA Profiling

(Elective)

Max. Marks: 100

Credit Weightage: 5

Total Teaching Hours: 75

Syllabus for Forensic Biology, Serology & DNA Profiling

Course Description:

This course provides an in-depth understanding of forensic biology, focusing on the analysis of body fluids, wildlife forensics, forensic anthropology, and DNA profiling. It explores the identification and forensic significance of biological samples, wildlife crime investigations, and human remains analysis. The course also covers advanced DNA analysis techniques, forensic databases, and emerging trends in forensic genetics. Additionally, students will gain hands-on knowledge of instrumental techniques such as microscopy, chromatography, electrophoresis, and immunoassays, essential for forensic investigations.

Note: Paper will also cover case studies and recent studies.

Objectives:

- To equip students with knowledge of the composition, examination, and forensic analysis of various body fluids.
- To familiarize students with forensic methods for investigating wildlife crimes and utilizing entomology in forensic science.
- To develop expertise in forensic anthropological and odonatological evidence for human identification.
- To provide in-depth knowledge of forensic DNA analysis, including STRs, SNPs, and emerging genetic technologies.
- To train students in the application of advanced instrumental techniques for forensic investigations.

Course Outcomes:

1. Knowledge Outcomes:

At the end of the course, students will possess:
- Understand the forensic significance, composition, and testing methods for various body fluids.
- Gain knowledge of protected species, forensic identification, and analysis techniques.
- Learn the role of skeletal and dental evidence in human identification.
- Acquire expertise in DNA extraction, typing methods, forensic databases, and emerging technologies.

- Develop proficiency in microscopic, chromatographic, electrophoretic, and immunoassay techniques for forensic analysis.

2. Skill Outcomes:

At the end of the course, students will possess:

- Ability to identify and analyse body fluids using presumptive and confirmatory tests.
- Proficiency in investigating wildlife crimes and identifying protected species.
- Skill in analysing skeletal and dental evidence for human identification.
- Competence in DNA extraction, quantification, and forensic genetic analysis.
- Hands-on experience with microscopy, chromatography, electrophoresis, and immunoassays.

Course Content:

Unit-I: Biological Fluids and Trace Evidence

- Biological Fluids: Structure, composition, and forensic examination of body fluids such as blood and bloodstains, seminal stains, saliva, urine, pus, and feces.
- Hair Analysis: Anatomy of hair, collection methods, and forensic examination of human and animal hair.
- Fiber Analysis: Types of fibers, their properties, collection techniques, and forensic examination.

Unit-II: Wildlife Forensics and Entomology

- Importance of wildlife and the environment: Protected and endangered species of animals and plants.
- Types of wildlife crimes, investigation, and identification (conventional and modern methods for analysing pug marks, skins, hair, bones, feathers, etc.).
- Forensic entomology and its applications.

Unit-III: Forensic Anthropology and Odontology

- Human identification: Skeletal analysis, sex, age, and stature estimation.
- Forensic odontology: Dental records, bite mark analysis, and personal identification.
- Role of forensic evidence in anthropology and odontology.

Unit-IV: DNA Profiling

- DNA Structure and Sources: Composition and forensic sample types.
- Collection & Contamination: Proper handling and prevention methods.
- DNA Extraction & Quantification: Key isolation and measurement techniques.

- DNA Typing: STRs, Y-STRs, mtDNA, SNPs, etc. and their applications.
- Forensic DNA Databases: National and global databases for identification.
- Legal & Ethical Issues: Privacy, regulations, and admissibility.
- Emerging Trends: NGS, Epigenetics, AI in DNA profiling (STRmix, TrueAllele®, NOCIt, Foren Seq™, Gene Mapper® ID-X, FST), Phenotyping, and Sequence analysis.

Unit-V: Instrumental Techniques:

- Microscopic Techniques: Polarizing, Comparison, Stereomicroscope, Phase Contrast, Fluorescence, SEM, TEM, AFM, CLSM.
- Immunoassay Techniques: ELISA, RIA, FIA, CLIA, Immunoelectrophoresis.
- Electrophoretic Techniques: Agarose & PAGE, Capillary Electrophoresis, 2D-GE, PFGE, IEF.
- Chromatographic Techniques: TLC, HPTLC, GC/LC-MS, UHPLC, UPLC, Multidimensional, SFC.
- Spectroscopic & Molecular Techniques: UV-Vis, FTIR, Raman, Fluorescence, CD Spectroscopy, qPCR, Digital PCR, NGS, DNA Microarrays.

Suggested readings:

1. Li, Richard (2008)-*Forensic Biology: Identification and DNA Analysis of Biological Evidence*, 2nd Edition, CRC Press. ISBN: 978-0849339544.
2. Byers, Steven N. (2020)-*Introduction to Forensic Anthropology*, 6th Edition, Routledge. ISBN: 978-1138188840.
3. Reddy, K.S. Narayan (2017)-*The Essentials of Forensic Medicine and Toxicology*, 34th Edition, Jaypee Brothers Medical Publishers. ISBN: 978-9352701247.
4. Butler, John M. (2012)-*Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers*, 2nd Edition, Academic Press. ISBN: 978-0123749994.
5. Gennard, Dorothy (2012)-*Forensic Entomology: An Introduction*, 2nd Edition, Wiley-Blackwell. ISBN: 978-0470689020.
6. Crowe, Travis (2015)-*Forensic Serology Research*, Nova Science Publishers. ISBN: 978-1634638475.
7. Kuligowski, Jan A. & Butler, John M. (2010)-*Forensic DNA Analysis: A Laboratory Manual*, Academic Press. ISBN: 978-0123749987.
8. Blau, Soren & Ubelaker, Douglas H. (2016)-*Handbook of Forensic Anthropology and Archaeology*, 2nd Edition, Routledge. ISBN: 978-1138188840.
9. Hannah, L. & Eisenberg, J. T. (2009)-*Principles of Forensic DNA for Officers of the Court*, Academic Press. ISBN: 978-0123740366.
10. Tu, Anthony T. (1998)-*Forensic Serology: Mechanisms and Techniques*, CRC Press. ISBN: 978-0849312707.
11. Saukko, P. & Siegel, J. A. (2013)- *Encyclopedia of Forensic Sciences*, 2nd Edition, Elsevier. ISBN: 978-0123821652.

PhDFS-EL-102 (ii):Forensic Chemistry and Toxicology

(Elective)

Max. Marks: 100

Credit Weightage: 5
Total Teaching Hours: 75

Syllabus for Forensic Chemistry and Toxicology

Course Description:

This course provides a comprehensive understanding of forensic chemistry, focusing on the identification, analysis, and forensic significance of various chemical substances. It covers the examination of petroleum products, oils, fats, and alcoholic beverages, along with the detection of adulterants and spurious products. The course also delves into the classification and forensic analysis of drugs, poisons, and environmental pollutants. Students will gain hands-on experience with advanced analytical techniques, including microscopy, chromatography, spectroscopy, and electrophoresis, enabling them to effectively analyze forensic evidence and contribute to criminal investigations.

Note: Paper will also cover case studies and recent studies.
Objectives:

> To understand the composition, properties, and forensic significance of petroleum products, oils, and fats.
> To analyse alcoholic beverages, adulterants, and spurious products using forensic techniques.
> To classify and examine various drugs, poisons, and their forensic applications.
> To investigate environmental pollutants, sampling techniques, and remediation strategies.
> To gain proficiency in microscopic, chromatographic, spectroscopic, and electrophoretic techniques for forensic analysis.

Course Outcome:

1. Knowledge outcomes:
At the end of the course, students will:
- Understand the chemistry of fire, petroleum products, and forensic analysis of arson-related evidence.
- Acquire knowledge of the forensic examination of alcoholic beverages, adulterants, and spurious products.
- Comprehend the classification, preservation, and analytical techniques for drugs and poisons.
- Explore environmental forensics, pollutant identification, sampling methods, and remediation strategies.

- Develop expertise in the application of microscopic, chromatographic, spectroscopic, and electrophoretic techniques in forensic analysis.

2. Skill outcomes:

At the end of the course, students will:

- Ability to analyse petroleum products, drugs, poisons, and adulterants using forensic techniques.
- Hands-on experience with microscopy, chromatography, spectroscopy, and electrophoresis.
- Competence in handling, preserving, and analysing forensic evidence from crime scenes.
- Skills to identify pollutants, apply sampling techniques, and implement remediation strategies.
- Ability to interpret forensic data, assess case-related chemical evidence, and draw scientific conclusions.

Course Content:

Unit-I: Forensic Chemistry

- Arson: Introduction, chemistry of fire, scientific investigation, collection, preservation, and analysis of evidence.
- Petroleum Products: Origin, composition, properties, and testing of petroleum products; petroleum dyes and their analysis.
- Oils and Fats: Characteristics and analysis.

Unit-II: Alcohol: Adulteration and Analysis

- Liquor – Country Made Liquor: Characteristics, manufacturing, and analysis.
- Phamacokinetics of Alcohol: Metabolism and forensic significance of methanol, ethanol, and propanol.
- Forensic Examination: Trap cases, spurious jewellery, and cosmetics.

Unit-III: Drugs and Poisons

- Drugs: Classification, active components, forensic detection, and analysis.
- Poisons: Types, collection, preservation, and forensic examination.

Unit-IV: Environmental Forensics

- Principles & Pollutants: Scope, applications, pollution control, organic, inorganic, biological, radiological, and emerging contaminants.

- Forensic Techniques & Sampling: Isotope analysis, fingerprinting, remote sensing, biosensors, nanotech; air, water, soil, biota sampling, chain of custody, legal aspects.
- Analysis & Remediation: ICP-MS, XRF, Raman; microbial and chemical remediation.

Unit-V: Advanced Analytical Techniques:

- Microscopic Techniques: Polarizing, comparison, stereo, SEM, TEM.
- Chromatographic Techniques: Extraction (SPE, SDME, 3PEE, EME); TLC, HPTLC, GC-MS-HS, UHPLC, UPLC, multidimensional, supercritical fluid chromatography.
- Spectroscopic Techniques: Raman, FT-IR, NMR, EEFS, HSIS, MIS, ICP-MS.
- Electrophoretic Techniques: Microchip, NACE, IPG-IEF, CZE, MEKC, 2DE, FASI-CE, SPE-CE-MS.

Suggested readings:

1. Brown, W. (2011)-*Drinking, Drugs & Driving Drunk: How Different Drugs Affect the Driving Experience*, 2nd Ed., William Gladden Foundation Press.
2. Jickells S., Negrusz A. (2008)-*Clarke Analytical Forensic Toxicology*, Pharmaceutical Press, London.
3. Klaassen C., Doull J., and Casarett L.J. (2013)-*Toxicology: The Basic Science of Poisons*, McGraw Hill Publication.
4. Modi (2022)-*A Textbook of Medical Jurisprudence and Toxicology*, 27th Ed., LexisNexis.
5. Thompson, R.B. & Thompson, B.F. (2012)-*Illustrated Guide to Home Forensic Science Experiments*, O'Reilly Media, USA.
6. Watson, C.A. (1994)-*Official and Standardized Methods of Analysis*, Royal Society of Chemistry, UK.
7. Murphy, B.L. & Morrison, R.D. (2002)-*Environmental Forensics: Principles and Applications*, Academic Press
8. Morrison, R.D. & Murphy, B.L. (2003)-*Environmental Forensics: Contaminant Specific Guide*, Academic Press. Murphy, B.L., Morrison, R.D., & Spelman, F.T. (2004)-*Introduction to Environmental Forensics*, Academic Press.
9. Patnaik, P. (2010)-*Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes*, CRC Press.
10. Saukko, J.A. & Siegel, P.J. (2013)- *Encyclopedia of Forensic Sciences*, Elsevier.

PhDFS-EL-102 (iii): Digital & Cyber Forensics and IT Security
(*Elective*)

Max. Marks: 100

Credit Weightage: 5
Total Teaching Hours: 75

Syllabus for Digital & Cyber Forensics and IT Security

Course Description: This course provides a comprehensive understanding of mobile forensics, cyber security, data privacy, and cyber laws. It covers forensic analysis of mobile devices, identification of cybercrimes, malware, and cloud forensics. Students will explore cybersecurity threats, protection strategies, and legal frameworks, including the IT Act and data protection laws. The course also addresses ethical concerns related to emerging technologies like AI, IoT, and blockchain, equipping students with the skills to investigate, analyze, and mitigate cyber threats effectively.

Note: Paper will also cover case studies and recent studies.

Objectives:

- To understand mobile forensics, including security, acquisition, and analysis of Android, iOS, and other mobile platforms.
- To explore various types of cybercrimes, malware forensics, and cloud forensics techniques.
- To analyse cybersecurity threats, terminologies, and protection strategies for critical infrastructure.
- To examine data privacy, security issues, and legal frameworks like the Personal Data Protection Bill.
- To comprehend cyber laws, IT Act provisions, and ethical aspects of emerging technologies.

Course Outcome:
1. Knowledge outcomes:
At the end of the course, students will:
- Understanding the principles, tools, and challenges of mobile forensics for various operating systems.
- Identifying different types of cybercrimes, malware threats, and forensic investigation techniques.
- Gaining knowledge of cyber-security concepts, attack vectors, and protection strategies for critical infrastructure.

- Learning about data privacy, security challenges, and compliance with data protection laws.
- Exploring cyber laws, IT Act provisions, and ethical considerations in emerging technologies.

2. Skill outcomes:

- Proficiency in mobile forensics including data acquisition, analysis, and reporting for Android, iOS, and other platforms.
- Ability to investigate cybercrimes such as malware attacks, social media scams, and cloud-based threats.
- Expertise in cybersecurity practices for protecting critical IT infrastructure and mitigating cyber threats.
- Competence in data privacy and security with an understanding of compliance regulations and protection measures.
- Understanding of cyber laws and ethical hacking to analyze legal frameworks and emerging technology risks.

Course Content:

Unit-I: Mobile Forensics

- Introduction to mobile forensics: Feature phones vs. smartphones, challenges, mobile forensics tools, process, and mobile ecosystems.
- Internals of Android devices: Android security, acquisition, analysis, and reporting.
- Internals of iOS: iOS security, preservation, acquisition, analysis, and reporting.
- Windows Phone and Blackberry forensics.
- Drone Forensics: analysis of unmanned air vehicles (UAVs).

Unit-II: Cybercrime and Digital Forensics

- Definition, classification, and types of cybercrimes.
- Scams, identity theft, and fraudulent activities.
- Identification, analysis, and mitigation of malicious software.
- Investigation techniques and challenges in cloud-based crimes.
- Cyberbullying, online harassment, psychological assessment/testing, objective techniques, and psychological models of cybercrime.

Unit-III: Cyber Security

- Cyber security and the increasing threat landscape.
- Cyber security terminologies: Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker, non-state actors, cyber terrorism.

- Protection of end-user machines.
- Critical IT and National Critical Infrastructure.
- Cyber warfare.

Unit-IV: Data Privacy and Data Security

- Data, meta-data, big data, non-personal data.
- Data protection, data privacy, and data security.
- Personal Data Protection Bill and its compliance.
- Data protection principles.
- Big data security issues and challenges.
- Social media: Data privacy and security issues.

Unit-V: Cyber Law and Management

- Cybercrime and the legal landscape around the world.
- IT Act, 2000 and its amendments.
- Ethical aspects related to new technologies: AI/ML, IoT, Blockchain, Darknet, and social media.
- Cyber security policy and crisis management plan.
- National cyber security policy and strategy.

Suggested readings:

1. Belapure, S. & Godbole, N. (2011)-*Cyber Security: Understanding Cyber Crimes, Computer Forensics, and Legal Perspectives*, Wiley India Pvt. Ltd.
2. Denning, D.F. (1999)-*Information Warfare and Security*, Addison Wesley.
3. Oliver, H.A. (2015)-*Security in the Digital Age: Social Media Security Threats and Vulnerabilities*, CreateSpace Independent Publishing Platform.
4. Venkataramanan, N. & Shriram, A. (2017)-*Data Privacy: Principles and Practice*, CRC Press.
5. Brothy, W.K. (2005)-*Information Security Governance: Guidance for Information Security Managers*, 1st Ed., Wiley Publication.
6. Weiss, M. & Solomon, M.G. (2015)-*Auditing IT Infrastructures for Compliance*, 2nd Ed., Jones & Bartlett Learning.
7. Saukko, P.J. & Siegel, J.A. (2013)-*Encyclopedia of Forensic Sciences*, 2nd Ed., Elsevier.

PhDFS-EL-102 (iv): Questioned Documents, Fingerprints and Biometrics
(Elective)

Max. Marks: 100

Credit Weightage: 5

Total Teaching Hours: 75

Syllabus for Questioned Documents, Fingerprints and Biometrics

Course Description:

This course provides a comprehensive understanding of forensic documents and fingerprint analysis, focusing on the scientific examination of paper, ink, handwriting, signatures, and biometrics. It covers advanced techniques for detecting forged documents, analyzing anonymous writings, and developing fingerprints using modern forensic tools. Students will learn about various biometric identification methods, including fingerprint, iris, facial, and voice recognition. The course integrates practical applications with theoretical knowledge, equipping learners with essential skills for forensic investigations and legal proceedings.

Note: Paper will also cover case studies and recent studies.

Objective:
- To understand the composition, ageing, and examination of paper and ink in forensic investigations.
- To identify class and individual characteristics of handwriting and detect forged signatures.
- To explore traditional and modern techniques for fingerprint visualization, including nanotechnology-based methods.
- To develop proficiency in using microscopes, VSC, ESDA, and digital imaging for document and fingerprint analysis.
- To study the principles and applications of fingerprint, facial, iris, DNA, and voice biometrics in forensic science.

Course Outcomes:
1. Knowledge outcomes:
At the end of the course, students will:
- Gain in-depth knowledge of paper, ink composition, ageing techniques, and forensic examination methods.
- Learn about handwriting systems, individual and class characteristics, and methods for detecting forged and simulated signatures.
- Acquire knowledge of advanced fingerprint detection methods, including photoluminescence, chemical, and nano-particle-based techniques.

- Understand the use of microscopes, light sources, photography, VSC, ESDA, and digital imaging in forensic investigations.
- Explore various biometric techniques such as fingerprint, iris, retinal, facial, DNA, handwriting, and voice biometrics for forensic applications.

2. Skill outcomes:

At the end of the course, students will:
- Ability to analyse paper, ink, handwriting, and signatures for authenticity and forgery detection.
- Proficiency in detecting and developing fingerprints using advanced physical, chemical, and nanotechnology-based methods.
- Competence in using VSC, ESDA, and digital imaging techniques for forensic analysis.
- Understanding and applying biometric technologies like fingerprint, iris, facial recognition, and voice analysis.
- Expertise in forensic photography techniques and the use of light sources for document and fingerprint analysis.

Course Content:

Unit-I: Paper, Ink, and Writing Devices

- Paper: Composition, types, making process, and forensic examination.
- Ink: Composition, types, process, and forensic examination.
- Ageing of Paper and Ink: Methods of age determination in different documents.

Unit-II: Handwriting and Signature

- Handwriting: Writing systems, their types, class, and individual characteristics.
- Signature: Characteristics, genuine, simulated, and forged signatures.
- Anonymous Letters and Secret Writings.

Unit-III: Fingerprint Detection Techniques

- Techniques based on photoluminescence, physical, and chemical methods.
- Techniques not based on photoluminescence (e.g., powder, crystal violet, metal deposition).
- Time-Resolved Fingerprint Detection.
- Nanoparticles and Chemical-Free Fingerprint Development.

Unit-IV: Techniques in Document Analysis and Fingerprints

- Basic Measuring Tools, Microscopes, and Light Sources.
- Photography: Principles, techniques, equipment, and types.
- VSC (Video Spectral Comparator) and ESDA (Electrostatic Detection Apparatus).
- Digital Imaging of Fingerprints.

Unit-V: Biometrics

- Biometrics: Introduction, advantages, disadvantages, and applications.
- Fingerprint Biometrics.
- Iris, Retinal, and Facial Biometrics.
- DNA, Handwriting, and Voice Biometrics.

Suggested Books:

1. Ordway, H. (1982)-*Scientific Examination of Questioned Documents*, Elsevier.
2. Osborn, A.S. (1998)-*Questioned Documents*, 2nd Ed., Universal Law Publishing, Delhi.
3. Harrison, W.R. (2001)-*Suspect Documents: Their Scientific Examination*, Universal Law Publishing, Delhi.
4. Morris, R.N. (2001)-*Forensic Handwriting Identification*, Academic Press, London.
5. Huber, R.A. & Headrick, A.M. (1999)-*Handwriting Identification: Facts & Fundamentals*, CRC Press.
6. David, E. (1997)-*The Scientific Examination of Documents: Methods and Techniques*, 2nd Ed., Taylor & Francis.
7. McMenamin, G.R. (2002)-*Forensic Linguistics: Advances in Forensic Stylistics*, CRC Press, Washington D.C.
8. Maltoni, D. (2003)-*Handbook of Fingerprint Recognition*, Springer Verlag.
9. Cowger, J.E. (1983)-*Friction Ridge Skin: Comparison and Identification of Fingerprints*, CRC Press, Boca Raton.
10. Lee, H.C. & Gaensslen, R.E. (1991)-*Advances in Fingerprint Technology*, CRC Press, London.
11. Saukko, J.A. & Siegel, P.J. (2013)- *Encyclopedia of Forensic Sciences*, 2nd Ed., Elsevier.

PhDFS-EL-102 (v): Forensic Physics and Ballistics
(Elective)

Max. Marks: 100

Credit Weightage: 5
Total Teaching Hours: 75

Syllabus for Forensic Physics and Ballistics

Course Description:

This course provides an in-depth understanding of the forensic examination of physical evidence, firearms, ammunition, forensic audio-video analysis, forensic engineering, and advanced analytical techniques. It covers the identification and forensic significance of materials like paint, glass, soil, fiber, and tool marks, along with the classification and analysis of firearms and ammunition, including ballistics and gunshot residue. The course also explores forensic audio and video analysis, focusing on sound physics, speaker identification, and multimedia forensics. Additionally, it delves into forensic engineering aspects such as vehicle examination, speed determination, and road evidence analysis. The curriculum integrates advanced analytical techniques, including microscopic, chromatographic, and spectroscopic methods, along with forensic software tools like IBIS, Amped-FIVE, and IKAR-Lab, to equip students with practical expertise in forensic investigations.

Note: Paper will also cover case studies and recent studies.

Objectives:

- To Develop expertise in examining forensic materials like paint, glass, soil, fiber, and tool marks
- To Gain knowledge of firearm classification, ammunition identification, and ballistic examination techniques.
- To learn methods for speaker identification, signal processing, and multimedia forensics.
- To study vehicle examination, accident reconstruction, and road evidence assessment.
- To apply microscopic, chromatographic, and spectroscopic methods in forensic investigations.

Course Outcomes:

1. Knowledge outcomes:
At the end of the course, students will:
- Develop expertise in analysing physical evidence such as paint, glass, soil, fiber, and tool marks
- Gain knowledge of firearm classification, ammunition identification, and ballistic

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rpartment of Forensic Science
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Shimla-171005 HP

examination techniques.

- Understand sound physics, voice identification, and digital forensic techniques for multimedia evidence.
- Learn vehicle examination, speed determination, and accident reconstruction for forensic investigations.
- Acquire hands-on experience with microscopic, chromatographic, and spectroscopic methods for forensic analysis.

2. Skill outcomes:

At the end of the course, students will:

- Develop expertise in identifying and analysing physical evidence such as paint, glass, soil, and tool marks.
- Gain proficiency in firearm classification, ammunition analysis, and ballistics evaluation.
- Acquire skills in speaker identification, multimedia forensic analysis, and digital signal processing.
- Learn to assess vehicle damage, analyse speed determination, and evaluate forensic engineering aspects.
- Gain the use of microscopic, chromatographic, and spectroscopic methods for forensic investigations.

Course Content

Unit-I: Physical Evidence

- Forensic examination of paint, glass, soil, fiber, cement, and metals
- Tool Marks: Types, class and individual characteristics.
- Impression Marks: Compression, striated, combination of impression and striated marks, repetitive marks, footwear Impressions.

Unit-II: Firearms and Ammunition

- Firearms and country made: Characteristics, and forensic identification
- Ammunition: Types, classification, marks produced during firing and forensic identification
- Ballistics: Internal, external, and terminal ballistics
- Gunshot Residue (GSR): Bore, caliber, and choke determination

Unit-III: Forensic Audio and Video Analysis

- Physics of Sound and Vocal Tract Anatomy
- Electronics of audio recording, transmission, playback devices, noise, and distortion

- Forensic Speaker Identification: Various approaches, analog and digital signal processing.
- Video Evidence: Analysis, interpretation, and multimedia forensics.

Unit-1V: Forensic Engineering:

- Vehicle Examination: Common automobile components and failure analysis.
- Damage Assessment: Tyres (types, speed, load rating, failures), brakes (types, brake systems), door locks, speed recording devices.
- Safety Restraint Systems: Examination of seat belts, child seats, air bags.
- Vehicular Fires & Speed Determination: Skid mark measurement, yaw calculations, speed estimation on different road surfaces; Falls, flips, vault speeds, and special speed problems; Road evidence, road engineering, and design.

Unit-V: Analytical Techniques:

- Microscopic Techniques: Comparison, Confocal, SEM, TEM.
- Chromatographic Techniques: TLC, HPTLC, HPLC, UHPLC, SFC.
- Spectroscopic Techniques: FTIR, NMR, Raman, ICP-MS.
- Forensic Software & Databases: IBIS, Amped-FIVE, IKAR-Lab.
- Emerging Techniques: CE, MALDI, TOF-MS.

Suggested readings:

1. Bodziak, W. (2000) - Footwear Impression Evidence, 2nd Ed., CRC Press, Boca Raton, Florida.
2. David, A.C. (2001) - The Forensic Examination of Paints and Pigments, Taylor & Francis, New York.
3. Harry, H. (2001) - Forensic Voice Identification, Academic Press, London.
4. Rose, P. (2002) - Forensic Speaker Identification, Taylor & Francis, Forensic Science Series, London.
5. Byrd, M. (2001) - Crime Scene Evidence: A Guide to the Recovery and Collection of Physical Evidence, CRC Press, Boca Raton.
6. Heard, B.J. (1997) - Handbook of Firearms and Ballistics, Wiley and Sons, Chichester.
7. Schwoeble, A.J. & Exline, D.L. (2000) - Current Methods in Forensic Gunshot Residue Analysis, CRC Press, Boca Raton.
8. Skoog, D.A., West, D.M. & Holler, F.J. (1994) - Analytical Chemistry: An Introduction, Saunders College Publishing, Philadelphia, USA.
9. Dettean, J.D. (2002) - Kirk's Fire Investigation, Prentice Hall, Englewood Cliffs, N.J.
10. Saukko, J.A. & Siegel, P.J. (2013) - Encyclopedia of Forensic Sciences, 2nd Ed., Elsevier.

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