

University of Mumbai



No. UG/45 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head of the University Departments and Directors of the recognized Institutions in Science & Technology Faculty is invited to the syllabus uploaded by the Academic Council at its meeting held on 27th February, 2013 vide item No. 4.128 relating to the syllabus as per (CBSGS) for Sem. III & IV of M.Sc. in Forensic Science from the academic year 2013-14.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Forensic Sciences at its meeting held on 27th April, 2019 have been accepted by the Academic Council at its meeting held on 10th May, 2019 vide item No. 4.31 and that in accordance therewith, the revised syllabus as per the (CBCS) for the M.Sc. Forensic Science (Sem. III & IV) has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI - 400 032

9th July, 2019

To

ajay
(Dr. Ajay Deshmukh)
REGISTRAR

The Principals of the affiliated Colleges, the Head of the University Departments and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C./4.31/10/05/2019

No. UG/45 -A of 2019

MUMBAI-400 032

9th July, 2019

Copy forwarded with Compliments for information to:-

- 1) The I/c Dean, Faculty of Science & Technology,
- 2) The Chairman, Ad-hoc Board of Studies in Forensic Sciences,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Co-ordinator, University Computerization Centre,

ajay
(Dr. Ajay Deshmukh)
REGISTRAR

AC _____
Item no. _____

University of Mumbai



Syllabus for Semesters - III & IV

Program - M. Sc.
Faculty - Science
Course -Forensic Science

Choice based Credit System (CBCS)

With effect from the academic year 2019-20

1. Course Structure & Distribution of Credits

The M. Sc.in Forensic Science program is divided in four semesters with total 96 credits. The program consists of total 16 theory papers, total 7 practical lab courses and 1 project spread over four semesters. Each theory paper shall consist of four units. Lab course (practical paper) shall consist of minimum twelve experiments based on respective theory papers. For, M.Sc. - I (semester I & II) there shall be eight theory papers and four theory based lab courses (practical papers) and shall be common and compulsory to all admitted learners. For M. Sc.-II (semester III and IV) there shall be specializations in various subjects offered by the concerned Institution(s). Four Specializations viz. **1) Questioned Documents, Finger prints and Forensic Physics 2) Forensic Chemistry and Toxicology 3) Forensic Biology, Serology and DNA Finger Printing and 4) Digital & Cyber Forensics and IT Security** may be offered subject to the availability of students and by adopting allotment procedure as mentioned in the preceding para. Each semester shall have four theory papers and two theory based lab courses (practical papers) related to specialization. In the fourth semester students will carry out Research project/ Dissertation in place of one practical paper. Each theory course will be of 4 (four) credits, a practical lab course will be of 4 (four) credits and a project will be of 4 (four) credits. A student earns 24 (twenty four) credits per semester and total 96 (ninety six) credits in four semesters. The course structure is as follows,

Distribution of Marks and Credits: The number of theory/practical papers and marks/credit allotted for M. Sc. Forensic Science program shall be as under:

Year	Semester	No. of papers		Total Marks			Total Credits		
		Theory	Practical	Theory	Practical	Total	Theory	Practical	Total
M.Sc. – I (Common)	Sem.-I	04	02	400	200	600	16	08	24
	Sem.-II	04	02	400	200	600	16	08	24
M.Sc. – II (Specialization)	Sem.-III	04	02	400	200	600	16	08	24
	Sem.-IV	04	01 01 (project)	400	100 100	600	16	04 04	24
Total		16	08	1600	800	2400	64	32	96

M. Sc. - I: Semester I & Semester II

Each, semester-I and II shall have four theory courses and two practical courses. The details are as follows:

Theory Courses per semester = 4

Practical lab courses per Semester = 2

Workload = 16 hours per week

Workload = 16 hours per week

Paper Code	Paper Title	Lectures (Hrs)	Credits
Semester – I : Theory papers			
PSFS101	Crime Scene Science	60	04
PSFS102	Forensic Medicine	60	04
PSFS103	Digital and Cyber Forensics-I	60	04
PSFS104	Cyber Crime and Protection of Personal Data in Cyberspace	60	04
Total		240	16
Semester – I : Practical lab courses			
PSFS P101	Lab Course -1	120	04
PSFS P102	Lab Course -2	120	04
Total		240	08
Semester – II : Theory papers			
PSFS201	Fingerprint and Questioned Document	60	04
PSFS202	Data Processing in Forensic Science	60	04
PSFS203	Digital and Cyber Forensics-II	60	04
PSFS204	E-commerce, E-Governance and Online Dispute Resolution	60	04
Total		240	16
Semester – II : Practical lab courses			
PSFS P201	Lab Course -3	120	04
PSFS P202	Lab Course -4	120	04
Total		240	08

M. Sc. -II: Semester III & Semester IV

Each, Semester-III and IV shall have four theory courses and two practical courses of the specialization chosen by learner. The details are as follows:

Theory Courses per semester = 4

Workload = 16 hours per week

Practical lab courses per Semester = 2

Workload = 16 hours per week

Specialization - 1: Questioned Documents, Finger prints and Forensic Physics

Paper Code	Paper Title	Lectures (Hrs)	Credits
Semester – III : Theory papers			
PSFSQ301	Advanced Document Examination-I	60	04
PSFSQ302	Advanced Fingerprint Technology-I	60	04
PSFSQ303	Materials and Analytical Tools	60	04
PSFSQ304	Motor Vehicle Crimes and Accident Analysis	60	04
Total		240	16
Semester – III : Practical lab courses			
PSFSQ P301	Lab Course -5	120	04
PSFSQ P302	Lab Course -6	120	04
Total		240	08
Semester – IV : Theory papers			
PSFSQ401	Advanced Document Examination-II	60	04
PSFSQ402	Advanced Fingerprint Technology-II	60	04
PSFSQ403	Forensic Ballistics and Tool Marks Evidence	60	04
PSFSQ404	Physical Evidence Examination	60	04
Total		240	16
Semester – IV : Practical lab courses			
PSFSQ P401	Lab Course -7	120	04
PSFSQ P402	Project	120	04
Total		240	08

Specialization - 2: Forensic Chemistry and Toxicology

Paper Code	Paper Title	Lectures (Hrs)	Credits
Semester – III : Theory papers			
PSFSC301	Forensic Chemistry – I	60	04
PSFSC302	Forensic Examination of Drugs	60	04
PSFSC303	Modern Instrumental Technique – I	60	04
PSFSC304	Forensic Toxicology – I	60	04
Total		240	16
Semester – III : Practical lab courses			
PSFSC P301	Lab Course -5	120	04
PSFSC P302	Lab Course -6	120	04
Total		240	08
Semester – IV : Theory papers			

PSFSC401	Forensic Chemistry – II	60	04
PSFSC402	Forensic Pharmacology	60	04
PSFSC403	Modern Instrumental Technique – II	60	04
PSFSC404	Forensic Toxicology – II	60	04
Total		240	16
Semester – IV : Practical lab courses			
PSFSC P401	Lab Course -7	120	04
PSFSC P402	Project	120	04
Total		240	08

Specialization - 3: Forensic Biology, Serology and DNA Finger Printing

Paper Code	Paper Title	Lectures (Hrs)	Credits
Semester – III : Theory papers			
PSFSB301	Forensic Anthropology	60	04
PSFSB302	Molecular Biology and Immunology	60	04
PSFSB303	Forensic Biology	60	04
PSFSB304	Instrumentation in Forensic Biology	60	04
Total		240	16
Semester – III : Practical lab courses			
PSFSB P301	Lab Course -5	120	04
PSFSB P302	Lab Course -6	120	04
Total		240	08
Semester – IV : Theory papers			
PSFSB401	Advanced DNA Fingerprinting	60	04
PSFSB402	Microbial Forensics	60	04
PSFSB403	Ecosystem Management and Wildlife	60	04
PSFSB404	Forensic Pathology and Quality Management	60	04
Total		240	16
Semester – IV : Practical lab courses			
PSFSBP401	Lab Course -7	120	04
PSFSBP402	Project	120	04
Total		240	08

Specialization - 4: Digital & Cyber Forensics and IT Security

Paper Code	Paper Title	Lectures (Hrs)	Credits
Semester – III : Theory papers			
PSFSD301	Network Forensics	60	04
PSFSD302	Mobile Application Development	60	04
PSFSD303	Digital Electronics, Microprocessor and IoT	60	04

PSFSD304	Python Forensic	60	04
Total		240	16
Semester – III : Practical lab courses			
PSFSD P301	Lab Course -5	120	04
PSFSD P302	Lab Course -6	120	04
Total		240	08
Semester – IV : Theory papers			
PSFSD401	Forensic Multimedia Sciences	60	04
PSFSD402	Malware Analysis	60	04
PSFSD403	Secure Coding	60	04
PSFSD404	Emerging Trends in Cyber Forensic	60	04
Total		240	16
Semester – IV : Practical lab courses			
PSFSDP401	Lab Course -7	120	04
PSFSDP402	Project	120	04
Total		240	08

2. Award of Degree:

The candidate shall be awarded the degree of Master of Science in Forensic Science (**M. Sc. in Forensic Science**) after completing the course and meeting all the evaluation criteria. The statement of marks shall carry a name of the specializations as stated below.

No.	Specialization Chosen	Name appearing in the Statement of Marks	Name appearing in the Degree Certificate
1	Questioned Documents, Finger prints and Forensic Physics	M.Sc. in Forensic Science (Questioned Documents, Finger prints and Forensic Physics)	M.Sc. in Forensic Science
2	Forensic Chemistry and Toxicology	M.Sc. in Forensic Science (Forensic Chemistry and Toxicology)	M.Sc. in Forensic Science
3	Forensic Biology, Serology and DNA Finger Printing	M.Sc. in Forensic Science (Forensic Biology, Serology and DNA Finger Printing)	M.Sc. in Forensic Science
4	Digital & Cyber Forensics and IT Security	M.Sc. in Forensic Science (Digital & Cyber Forensics and IT Security)	M.Sc. in Forensic Science

3. Scheme of Examination and Passing:

1. Each theory paper shall have 40% Term Work (TW) / Internal Assessment (IA) and 60% external (University written examination) of 2.5 Hours duration.
2. Each lab course shall have an external examination for 100 marks of 6 Hours duration. The distribution of marks shall be – Two experiments for maximum 40 marks each, Viva-voce for maximum 10 marks and maximum 10 marks for certified journal.
3. Project work shall have an external evaluation for 100 marks.
4. The external examination for Theory and Practical/ Project shall be conducted by the University at the end of each Semester.
5. The marks for Term Work (TW) / Internal Assessment (IA) shall be assigned on the basis of seminar/presentations / tutorials/ home assignments to be conducted by the concerned Institution/ Department.
6. Term Work / Internal Assessment - IA (40%) and University examination (60%) - shall have separate heads of passing. For theory courses, internal assessment shall carry 40 marks and Semester-end examination shall carry 60 marks for each theory Course.
7. To pass, a student has to obtain minimum grade point E, and above separately in the IA and external examination.
8. The candidates shall appear for external examination of 4 theory courses each carrying 60 marks of 2.5 hours duration and 2 practical courses each carrying 100 marks of 6 hours duration at the end of each semester.
9. The candidate shall prepare and submit for practical examination a certified Journal based on the practical course carried out under the guidance of a faculty member with minimum number of experiments as specified in the syllabus. Department(s) are advised to arrange maximum number of experiments from the list provided in the syllabus, minimum number of experiments are specified only for the purpose of certification of journal.

4. Standard of Passing for University Examinations:

As per ordinances and regulations prescribed by the University for semester based credit and grading system.

5. Standard point scale for grading:

Grade	Marks	Grade Points	Performance
O	80.00 and above	10	Outstanding
A +	70-79.99	9	Excellent
A	60-69.99	8	Very Good
B+	55-59.99	7	Good
B	50-54.99	6	Above Average
C	45-49.99	5	Average
D	40-44.99	4	Pass
F	Less than 40	0	Fail

6. Grade Point Average (GPA) calculation:

1. GPA is calculated at the end of each semester after grades have been processed and after any grade have been updated or changed. Individual assignments / quizzes /surprise tests / unit tests / tutorials / practical / project / seminars etc. as prescribed by University are all based on the same criteria as given above. The teacher should convert this marking into the Quality-Points and Letter-Grade.
2. Performance of a student in a semester is indicated by a number called Semester Grade Point Average (SGPA). It is the weighted average of the grade points obtained in all the subjects registered by the students during the semester

$\sum_{i=1} C_i p_i$	C_i = The number of credits earned in the i^{th} course of a semester.
$\text{SGPA} = \frac{\sum_{i=1} C_i p_i}{\sum_{i=1} C_i}$	p_i = Grade point earned in the i^{th} course $i = 1,2,\dots,n$ represents number of courses for which the student is registered.

- 3 The Final remark will be decided on the basis of Cumulative Grade Point Average (CGPA) which is weighted average of the grade point obtained in all the semesters registered by the learner.

$\sum_{j=1} C_j p_j$	C_j = The number of credits earned in the j^{th} course upto the semester.for which h the CGPA is calculated
$\text{CGPA} = \frac{\sum_{j=1} C_j p_j}{\sum_{j=1} C_j}$	p_j = Grade point earned in the j^{th} course* $j = 1,2,\dots,n$ represents number of courses for which the student is registered upto the semester for which the CGPA is calculated.
	<p>* : A letter Grade lower than E in a subject shall not be taken into consideration for the calculation of CGPA</p> <p>The CGPA is rounded upto the two decimal places.</p>

7. Eligibility:

B.Sc. Forensic Science from recognized University / Institution with all papers dedicated to various disciplines of Forensic Science.

8. Intake Capacity:

Sanctioned Seats to be filled as per following criterion:

- I) 80% seats shall be reserved for the eligible candidates those have obtained the B.Sc. Forensic Science degree from Mumbai University.
- II) 10% seats shall be reserved for the eligible candidate who has obtained the B.Sc. Forensic Science degree from the other University within the State of Maharashtra. One seat will be for open and the other seat will go for student having higher percentage from any reserved category.
- III) 10% seats shall be reserved for the eligible candidate who has obtained the B.Sc. Forensic Science degree from the other State Universities and will be filled on the basis of merit.

Note: 1. The marks obtained by candidate from criteria II & III shall not be less than the marks of the last candidate admitted in respective category from criteria I above .If candidates with such marks are not available then the seats will be filled up by candidate pertaining to criteria I.

2. If any seat remains vacant then it will be allotted to candidate pertaining to criteria I) above further vacant seat/s if any will be allocated to waitlist candidate belonging to criteria II or then to criteria III.

3. Prevailing reservation policies of Maharashtra state and University of Mumbai will be applicable.

4. Admissions will be strictly on the basis of merit and reservation policies.

9. Allotment of specialization and Minimum intake capacity:

The specialization to the students shall be allotted in the beginning of Semester – III, on the basis of choice and merit (M.Sc. - I, semester I and II marks taken together) of the student. There shall be minimum 25% of the intake capacity / on roll students for each specialization. However, if the criterion of minimum intake capacity for a particular specialization as mentioned is not full filled, in such case the students will be diverted to other specialization strictly based on the marks obtained by him/her at M.Sc.-I examination. In such situation the decision of the Head of the concerned Institution shall be final.

10. Results Grievances/ Redressal and ATKT rules:

Result Grievances/redressal/revaluation and ATKT rules shall be as made applicable by the University from time to time.

Syllabus for
M. Sc.
Forensic Science
Semesters - III & IV

Specialization - 1:

Questioned Documents, Finger prints and Forensic Physics

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER -III (Theory Paper)

PSFSQ301-Advanced Document Examination-I

Hours per week – 04

Credits – 04

Unit-I: Paper and ink examination

- Paper: Historical development, composition, types of paper; paper making process: raw materials, pulping, bleaching, pressing, drawing, sheet formation process, and chemical treatment.
- Forensic examination of paper: Size, color, thickness, opacity, porosity, pore size distribution, gas permeability, wetting and penetration of liquids, thermal properties, water mark and wire mark.
- Ink: Historical development, types of ink, making process, chemical composition: dyes, pigments, vehicles, resins, lubricants; Ink formulations: Ballpoint pen, gel-pen, roller-ball pens, fountain pen, printing inks.
- Forensic examination of ink: Preliminary, microscopic, digital imaging, chemical testing, TLC, HPTLC, HPLC, FTIR, UV-Visible, raman and mass spectrometry.
- Aging of paper: Aging and its types, factors affecting aging of paper: environmental effect (temperature and humidity), chemical degradation, oxidation reaction to polysaccharides, cellulose, lignin.
- Aging of ink: Aging process of ink and methods of ink dating.
- Aging of document: Methods of age determination in different documents.

Unit-II : Forensic questioned document examination

- Primary examination: General observation, skillful handling, primary tools and techniques, principle points for consideration and cautions.
- QD Protocol: Classes of questioned document, care of questioned document, standards for comparison.
- Photography of documents: Principle of document photography, microscope and microphotography, stereoscopic photography, special cameras and devices for document photography.
- Measures and appliances: Special instruments in document examination, ordinary magnifier, linen tester, universal conversion scale, micrometer, caliper, ratchet stop, graticule, protractor, needle pointed parallel dividers, diagonal measurement scale, type-writing protractor, curvemeter, glass scale tester for alignment and spacing and transmitted light table.
- Writing instruments: Different type of writing devices-lithographic pen, falcon pen, coarse pointed pen, ball pen, pencil and other type of color pens.

- Printing technology and its forensic examination

Unit-III : Handwriting and signature

- Handwriting: Relation of system of writing to questioned document, variation in genuine writing, comparison for similarities and differences, individual characteristics elements in writing, order and sequence of writing, simulated and copied handwriting forgeries, examination of disputed writing.
- Signature: Body of signature, guided-hand signature, assisted signature, ballot marks, check marks, rubrics and perhaps in signature. Trace signature forgeries, proof of genuine signature, forgery over genuine signature.
- Anonymous letter: Analysis of language, inconspicuous characteristics, progressive variation, a suicide note, sex indication, angular hand, side by side analysis, date and folds on paper.
- Photocopiers and typewriters: Working mechanism of photocopier, forensic examination of photocopier and photocopied documents; working mechanism of typewriter, forensic examination of typewriter and typescripts.

Unit-IV: Instruments for document examination

- Document illumination techniques: Light sources, illuminating devices, colour filter, stock and anti stock.
- Document magnification techniques: Micro magnification, stereo magnification, magnification with fluorescent.
- Electrostatic development: Development of perforated document, indented document, secret document, very old document of historic importance.
- Thermal developer: Instrument used for thermal development on special documents.
- Spectral comparator: Light sources, magnification, filters, UV-Vis region, IR region, spectrograph, barcode, lateral comparison, other document examination features.

Reading material:

1. Albert Osborn, Hand book of questioned document examination.
2. Richard Brunelle, Advances in the forensic analysis and dating of writing ink, Charles C Thomas Publisher.
3. Richard L. Brunelle, Robert W. Reed, Forensic Examination of Ink and Paper, C.C. Thomas.
4. Jane Lewis, Forensic Document Examination: Fundamentals and Current Trends, Elsevier.
5. Jan Seaman Kelly, Brian S. Lindblom, Scientific Examination of Questioned Documents, CRC Press.
6. Ordway Hilton, Scientific Examination of Questioned Documents, CRC Press.

7. David Ellen, Scientific Examination of Documents: Methods and Techniques, CRC Press.
8. NIIR Board of Consultants & Engineers, Handbook on Printing Technology (Offset, Flexo, Gravure, Screen, Digital, 3D Printing), Asia Pacific Business Press Inc.
9. NIIR Board Author, The Complete Book on Printing Technology, Asia Pacific Business Press Inc.
10. Prakash Shetty, Science and Technology of Printing Materials, MJP Publishers.
11. Wilson R. Harrison, Suspect Documents: Their Scientific Examination, Sweet & Maxwell

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER -III (Theory Paper)

PSFSQ302-Advanced Fingerprint Technology-I

Hours per week – 04

Credits – 04

Unit-I: Fingerprint detection techniques-I

- **Not based on Photoluminescence:** Powder, crystal violet, iodine fuming, super glue, ninhydrin, metal deposition methods: silver nitrate, physical developer, multi metal deposition, vacuum metal deposition.
- **Based on Photoluminescence (Physical methods):** Inherent fingerprint fluorescence, staining with fluorescent dyes, luminescent powders, vapor staining.
- **Based on Photoluminescence (Chemical methods):** DMAC, Benzo(f) ninhydrin, 5-methoxyninhydrin, amino acid reagents: ninhydrin/zinc chloride, ninhydrin analogs, 1,8- Diazafluoren-9-one, 1,2-Indanediones, miscellaneous amino acid reagents.
- **Lipid reagent:** Sudan black, oil red O, Nile red, europium chelates, solvent systems, enzymes, blood prints, phase transfer catalysis, sequential procedures.

Unit-II: Fingerprint detection techniques-II

- **Time resolved fingerprint detection:** Background fluorescence, charge transfer phosphorescent compounds, lanthanide based fingerprint treatments, recent lanthanide strategies for fingerprint detection.
- **Nanoparticles:** Phase resolved imaging; Nanoparticles: structure and properties, affinity for papillary secretions, lipophilic interaction, chemical reaction; various nanoparticles used for visualization: aluminium, cadmium, europium, gold based, iron based, silica based, silver based, titanium based, zinc based; photo luminescent semiconductor nanocomposites: CdS nanocrystals, CdS/dendrimer.
- **Chemical free fingerprint development:** Non-chemical methods, thermal methods, thermal techniques for papers and documents (historic documents, banknotes, office paper, white and brown paper envelopes, newspaper, notepaper, thermal receipts), detection and enhancement by thermal methods, fluorescent by-product, blue or blue/green illumination and appropriate filter.

Unit-III: Development of fingerprints on challenging surfaces

- Introduction, arson: Soot removal techniques, soot removal from blood prints, effects of flammable liquids on latent friction ridge impressions, recovery of friction ridge impressions in blood.
- Chemical contamination, biological contamination, radiological, decontamination, explosives.
- Other substrates: Sticky tapes or adhesive surfaces, human skin, wet and submerged

surfaces, firearms and firearms related evidence (casings and cartridges).

- Desiccated remains.

Unit-IV: Instrumental techniques in fingerprint development

- Illuminating light sources: UV, violet, blue, blue/green, green, orange, red and infrared narrow bandwidth illumination.
- Fingerprint fuming systems: Cyanoacrylate (superglue) fingerprint fuming cabinets, field fingerprint fuming chamber, large area fuming system, other chamber system.
- Fingerprint enhancement techniques: Thermal fingerprint developer, anti-stock powder imaging.
- Fingerprint treatment methods on multi-coloured, densely patterned backgrounds, reflective metal surfaces and substrates that fluoresce at the same wavelengths as common fluorescent fingerprint treatments.

Reading material:

1. Lee and Gaensslen's Advances in Fingerprint Technology, Third Edition (2013), CRC press.
2. Peter Komarinski, Automated Fingerprint Identification Systems (AFIS), Elsevier Academic Press, 2005.
3. E. Roland Menzel, Fingerprint Detection with Lasers, Second Edition, Marcel Dekker, 1999.
4. Advances in Fingerprint technology, Edited by Henry C lee, Robert Ramotowski and R.E Gaensslen, CRC press 2001.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER -III (Theory Paper)

PSFSQ303: Materials and Analytical Tools

Hours per week – 04

Credits – 04

UNIT –I: Materials

Engineering Materials: Classification (metals, ceramics, polymeric, composites, electronics, biomaterials, advanced materials); Material structure (macrostructure, microstructure, substructure, crystal structure, electronic structure, nuclear structure), alloy systems, solid solutions.

NanoMaterials: Nanoscale and its significance, Nano material production techniques: Bottom-up top down technique, production of Nano layers, synthesis of Nano particles and carbon nano tubes; Applications of Nano materials in forensic science: Fingerprint identification, explosive residue detection, DNA analysis, Nano trackers, screening of drug-facilitated crime, estimation of time since death, security etc.

Taggant materials: Taggant materials (physical, chemical, spectroscopic, DNA etc.) and their applications in forensic science (property marking, anti counterfeiting, tracking, monitoring etc.).

UNIT –II: Crystal geometry

Overview of space lattice, crystal structure and unit cell. Bravais lattices, symmetry in crystals, calculations of parameters (unit cell volume, number of atoms per unit cell, co-ordination number, atomic radius, packing fraction, void space, density of crystal) of SC, BCC, FCC and HCP structures.

Atom positions in cubic cells, indices of crystallographic direction, lattice planes and miller indices, sketching a lattice plane (hkl), introductory idea of reciprocal lattice. Unit cell volumes, plane spacing and interplaner angles in cubic, tetragonal, hexagonal, rhombohedral, orthorhombic, monoclinic and triclinic structures.

UNIT –III: Crystal Structure Analysis

X-Ray diffraction, reflection of X-ray from different planes and Bragg's law, Bragg's spectrometer, X-ray diffraction methods (Laue method, powder crystal method, rotating crystal method), XRD pattern analysis (Intensity analysis, particle size estimation, indexing of pattern and crystal structure determination). Forensic applications of XRD, hard and soft X-Rays. Introduction to various crystal defects.

UNIT –IV: Analytical Tools

Principle, working and instrumentation of: XRF, EDXRF, FTIR, Raman spectrometer, SEM, TEM, AAS, ICP-MS, LA-ICP-MS, NMR and NAA.

Reading Material:

1. Material Science, 2nd Edition, S.L. Kakani and Amit Kakani, New Age Int. Publisher.

2. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi.
3. Alok Pandya, Ritesh K Shukla, New perspective of nanotechnology: role in preventive forensic, review, Egyptian Journal of forensic sciences (2018) 8:57
4. Arshad A, Farrukh M, Ali S, Khaleeq-ur-Rahman M, Tahir M (2015) Development of latent fingerprints on various surfaces using ZnO-SiO₂ nanopowder. *J Fore Sci* 60:1182–1187
5. Chen Y (2011) Forensic applications of nanotechnology. *J Chin Chem Soc* 58:828–835
6. Lad N, Kumar A, Pandya A, Agrawal YK (2016) Overview of nano-enabled screening of drug-facilitated crime: a promising tool in forensic investigation. *Trends Anal Chem* 80:458–470
7. Lodha A, Pandya A, Sutariya P, Menon S (2013) Melamine modified gold nanoprobe for “on-spot” colorimetric recognition of clonazepam from biological specimens. *Anal* 138:5411–5416
8. Meng H, Caddy B (1997) Gunshot residue analysis—a review. *J Fore Sci* 42:14167J
9. Pandya A, Goswami H, Lodha A, Menon S (2012) A novel nanoaggregation detection technique of TNT using selective and ultrasensitive nanocurcumin as a probe. *Anal* 137:1771
10. Shinde SA, Malve MK, Prabha C, Garad MV (2010) Nanotechnology and forensic science. *Nanotech and Nano Sci* 1(1):19–21
11. Shukla RK (2013) Occupational exposure of nanoparticles in forensic science: a need of safe use. *Int J Fore Sci Pathol* 1(3):7–10
12. Stankova D (2015) Application of Nanotechnology In Security
13. Taggant materials in Forensic Science: A review, James Gooch, Barbara Daniel, Vincenzo Abbate, Nuzianda Frascione, *Trends in Analytical Chemistry* (2016),
14. Introduction to Solid State Physics; Charles Kittel, Wiley India Pvt. Ltd.
15. Elements of X-Ray Diffraction; B.D. Cullity and S. R. Stock, Pearson.
16. Engineering Physics; M.N. Avadhanulu and P.G. Kshirsagar, S.Chand Company.
17. A Textbook of Physical Chemistry, Vol-1, K.L.Kapoor, Mc Graw Hill.
18. Instrumental Method of Chemical Analysis, by B K Sharma.
19. Instrumental methods of chemical analysis, Gurudeep R. Chatwal, Sham K. Anand, Himalaya publishing house.
20. Principle of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publishing Co.
21. Analytical Chemistry: Theory and Practice, by R.M. Verma, 3rd edition.
22. Electron microscopy and analysis, third edition, Peter J. Goodhew, John Humphreys, Richard Beanland, published 2001 by Taylor and Francis, London and Newyork
23. Forensic Science in Criminal Investigation & Court Evidence, V.N. Sehgal, Selective & Scientific Books, New Delhi.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER -III (Theory Paper)

PSFSQ304: Motor Vehicle Crimes and Accident Analysis

Hours per week – 04

Credits – 04

UNIT –I: Understanding the vehicle

Overview of exterior and interior body parts of various vehicles; Introduction to: Steering system, suspension system, braking system, chassis and chassis numbers, wheels and tyres; Automotive engines: Types and general technical specifications (manufacturer, type, bore, stroke, capacity, compression ratio, valve gear, engine control, maximum power, maximum torque, fuel tank capacity etc.) of various vehicles and their relevance; Vehicle Identification Number (VIN) locations, engine number and RTO registration number, relevant vehicle documents.

UNIT –II: Motor vehicle crimes

Crimes and vehicles, theft of vehicles, abandoned vehicles, vehicles involved in terrorism/explosion, road accidents and main contributing factors (equipment failure, roadway design, poor roadway maintenance, driver behaviour), motor vehicle fire (exterior and interior examination, fuel tank/capacity examination, electrical systems, collection of fire evidence, evidence containers). Evidentiary clues: Vehicle, scene, culprit/victim, eye witnesses. Procurement/collection and evaluation of: Tyre marks/skid marks, tyre residue, tyre burst, scratch marks, head/tail light and other fragments, bulbs and filaments, glass fragments, blood, hairs, fabric, finger prints/foot marks, paint samples, vehicle registration and insurance related documents, engine number, VIN (constitution, decoding and interpretation), scene photographs and plans. Tyre evidence: Original equipment tyres, replacement tyres and tyre construction, tread nomenclature and side wall information, noise treatment, tread wear indicators, retread tyres. Tire track evidence: Stance, wheelbase, turning diameter, tire position in turn.

UNIT –III: Vehicle examination

Vehicle identification, examination of vehicle licence plate, examination of vehicle documents, Restoration of VIN/serial numbers, anti-theft systems, examination of steering columns and ignition locks, examination of vehicle keys, examination of burnt vehicles, examination of vehicles recovered underwater.

UNIT –IV: Vehicular accident reconstruction

Inspection techniques, types of vehicle collision (head-on collisions, front-to-back collisions and eccentric collisions). Application of Impulse-Momentum theory to Linear Central Impact, Oblique Central Impact and Eccentric Impact and Rotations. Application of Poisson impact theory to vehicular collisions. Simple falls of vehicles. Breaking efficiency (motor cycle and four-wheeler). Types of skid marks and evidential value, Estimation of speed from skid marks on

plane, up/down-graded roads. Occupants' kinematics, biomechanics of injuries.

Reading Material –

1. Automobile Engineering, R.B. Gupta, Satya Prakash, New Delhi.
2. Basic automobile engineering, C.P. Nakra, Dhanpat Rai Publication Company
3. Automotive Mechanics, N. K. Giri, 8th Edition, Khanna Publishers, New Delhi.
4. Automobile Engineering, Kripal Singh.
5. Forensic Examination of Stolen-Recovered and other crime related vehicles, Eric Staufer.
6. Forensic Science, An Introduction to Scientific and Investigative Techniques, 2nd Edition, Stuart H. James and Jan J. Nordby.
7. Forensic Engineering Fundamentals, Harold Franck and Darren Frank, CRC Press.
8. Encyclopaedia of Forensic Science Vol.1& 3, J A Siegel, Pekka J Saukko et al, Academic Press.
9. Highway Engineering, S K Khanna C E G Justo. Nem Chand and Bros, Roorkee, 2001.
10. Investigating automobile fire causes, Glen A. Shifflett, Journal of criminal law and criminology, 1958, volume 49, issue 3, article 14.
11. Automobile arson investigations, William J. Davis, Journal of criminal law and criminology, 1946, volume 37, issue 1, article 8.
12. Fire investigator: principles and practice, 4th edition, Jones and Bartlett
13. Application of Impulse Momentum Theory to Vehicle Collisions, A. G'üven "OZTAS, Tr. J. of Engineering and Environmental Science, 23 (1999) , 455 - 464.
14. Milan Batista. On the mutual coefficient of restitution in two car collinear collisions, 2006.
15. Website www.crashforensics.com, John C Glennon, Chartered.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER -III (Lab Course)

PSFSQ P301: Lab Course -5

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Analysis of ink using Thin Layer Chromatography.
2. Analysis of ink using FTIR/UV-Visible spectroscopy.
3. Analysis of ink using HPLC/HPTLC.
4. Microscopic examination of different ink.
5. Microscopic examination of paper.
6. Physical examination of paper.
7. Age determination of paper and ink for a document.
8. Handwriting examination.
9. Signature examination.
10. Examination of anonymous letter.
11. Barcode examination.
12. Ink separation using filter.
13. Examination of photocopied documents.
14. Examination of printed documents.
15. Examination of typewritten documents.
16. Forensic Linguistics examination.
17. Stylistics examination.
18. Examination of authorship and psycholinguistics.
19. Examination of financial statements.
20. Fraud detection and evidence creation.
21. Cheque fraud examination.
22. Payroll fraud examination.
23. Counterfeit document examination.
24. Numismatic forgery examination.
25. Credit and debit cards examination.
26. Security documents examination.
27. Development of fingerprint based on non-photoluminescence.
28. Development of fingerprint using 1, 8-diazafluoren-9-one.
29. Development of fingerprint using super glue fuming.
30. Development of fingerprint using fluorescent dyes.
31. Development of fingerprint using lipid reagents.

32. Development of fingerprint using amino reagents.
33. Development of fingerprint using Alternate Light Sources.
34. Development of bloody fingerprints.
35. Development of fingerprints using non-chemical methods.
36. Development of fingerprints on various challenging surfaces.
37. AMBIS- System Architecture analysis and fingerprint scanning system.
38. Examination and evaluation of AFIS reports.
39. Fluorescence imaging of fingerprints.
40. Infrared imaging of fingerprints.
41. Fingerprint photography and comprehensive enhancement.
42. Recording of postmortem fingerprints, palmprints and footprints.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER-III (Lab Course)

PSFSQ P302: Lab Course -6

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Finding Miller Indices.
2. Sketching various crystal planes.
3. Determination of number of atoms per mm^2 in a plane of unit cell.
4. Intensity analysis of XRD pattern.
5. Determination of crystallite size from a given XRD pattern.
6. Indexing of planes in XRD pattern.
7. XRD pattern analysis of Nano material.
8. VIN collection from various vehicles and interpretation.
9. Collecting Chassis numbers of various motor bikes and comparative study.
10. Comparative study of keys of various vehicles.
11. Examination of broken head/tail lights.
12. Examination of bulb filament.
13. Examination of driving license/vehicle RTO registration/vehicle insurance documents.
14. Measurement of stance and wheelbase.
15. Tyre sidewall information and interpretation.
16. To study class characteristics and wear and tear of various tyres.
17. Casting and evaluation of tyre impressions.
18. Measurement of turning diameter/radius of vehicle.
19. Measurement of peripheral vision.
20. Sample calculations of accident reconstructions.
21. Estimation of vehicle speed from skid lengths considering braking efficiency.
22. Analysis of simple fall of vehicles-sample calculations.
23. Physical examination of accidental vehicle- Visit to authorized auto garage.
24. Case study of vehicular accident.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER-IV (Theory Paper)

PSFSQ401-Advanced Document Examination-II

Hours per week – 04

Credits – 04

Unit-I: Forensic linguistics and stylistics

- Forensic linguistics: Introduction, historical development and scope.
- Disciplines of forensic linguistics: Phonetics, semantics, discourse analysis, pragmatics.
- Linguistic variations: Types of variation, individual and group variation, dialect and idiolect, analysis of variation.
- Stylistics: Introduction, style in language, linguistic stylistic, qualitative and quantitative analysis of style.
- Style markers: Text format, number and symbol, abbreviation, punctuation, capitalization, spelling, word formation, syntax, error and correction, high frequency word and phrases.
- Application of forensic linguistics: Examination of anonymous letter, authorship analysis, plagiarism detection, psycholinguistics.

Unit-II: Forensic accounting and auditing

- Basic concept on account: Accounting process, recording of transactions, financial statements.
- Fraud: Brief history and types of fraud-employee fraud and financial statement fraud.
- Forensic accounting and its application, fraud detection, role of forensic accountant, sources of information.
- Bank and financial institutions fraud, insurance fraud, cheque fraud, payroll fraud and their investigation.
- Forensic auditing and its types.

Unit-III: Security documents and examination of forgery

- Security documents: Definition and types of currency, travelling documents, stamp papers.
- Security features of security documents.
- Document counterfeiting: Nature, types of counterfeiting.
- Forensic examination of security documents: Equipments and methods.
- Numismatic forgery: Introduction, tool, equipments and method of forgeries.
- Forensic identification of fake coins.

- Credit and debit cards: Definition, processing, types of fraud, security features and forensic examination.

Unit-IV: Modern methods in document examination

- Forensic document examination in Daubert era.
- Individuality of handwriting and its statistical validation.
- Computer based systems for handwriting and signature examination: FISH, WANDA, CEDAR-FOX, and FLASH-ID.
- ASTM and SWGDOC guidelines for document examination and handwriting analysis.
- Demonstrative charts using modern techniques: Photoshop chart, PowerPoint chart, Write-on 2 chart.

Reading material:

1. Gerald R. McMenamin, *Forensic Linguistics: Advances in Forensic Stylistics*, CRC Press.
2. Tommie W. Singleton, Aaron J. Singleton, G. Jack Bologna, Robert J. Lindquist, *Fraud Auditing and Forensic Accounting*, John Wiley & Sons.
3. Jane Lewis, *Forensic Document Examination: Fundamentals and Current Trends*, Elsevier.
4. Jan Seaman Kelly, Brian S. Lindblom, *Scientific Examination of Questioned Documents*, CRC Press.
5. Mark J. Nigrini, *Forensic Analytics: Methods and Techniques for Forensic Accounting Investigations*, John Wiley & Sons
6. Joseph R. Petrucelli, *Detecting Fraud in Organizations: Techniques, Tools, and Resources*, John Wiley & Sons
7. Mary-Jo Kranacher, Richard Riley, Joseph T. Wells, *Forensic Accounting and Fraud Examination*, John Wiley & Sons.
8. Steven L. Skalak, Thomas W. Golden, Mona M. Clayton, Jessica S. Pill, *A Guide to Forensic Accounting Investigation*, John Wiley & Sons.
9. Larry Rittenberg, Karla Johnstone, Audrey Gramling, *Auditing: A Business Risk Approach*, Cengage Learning.
10. George A. Manning, *Financial Investigation and Forensic Accounting*, CRC Press.
11. Jack Bologna, Robert J. Lindquist, *Fraud auditing and forensic accounting: new tools and techniques*, Wiley.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER-IV (Theory Paper)

PSFSQ402 -Advanced Fingerprint Technology-II

Hours per week – 04

Credits – 04

Unit-I: Automated Fingerprint Identification System and Integrated Biometric Identification System

- Introduction to AFIS: History, First AFIS system, growth and development of AFIS system, biometric and live scan.
- Working of AFIS: Databases, processing, ten print, latent print process, and unsolved latent search.
- Identification: AFIS components, fingerprint cards and images, AFIS names and minutae searches, types of AFIS search, AFIS reports.
- AMBIS- Integrated Biometric Identification System, System Architecture, CCTNS.
- Working and data management; issues of AFIS and AMBIS: SWOT analysis-AFIS strengths and weaknesses, opportunities and threats.

Unit-II: Fingerprint imaging

- Fingerprint Imaging: Fluorescence imaging, infrared imaging, reflected long wave UV imaging, cylindrical surface unwrapping imaging, digital enhancement and imaging, image validation.
- Fingerprint Photography Workstations: Detection, capture, enhancement, surface or background, color contrast, color filter, fingerprint photography, comprehensive imaging system, fully-integrated illumination and image capture technique.
- Recovery Technology, recovery of latent print on special exhibits, RECOVER Compact Laboratory System, working:
 - RECOVER finger marks from fired ammunition casings.
 - RECOVER finger marks from items purposely washed 'clean'.
 - RECOVER finger prints from detonators, IED's and other explosive material.

Unit-III: Post-mortem fingerprinting

- Introduction, equipment and tools for postmortem fingerprinting, recording fingerprints, palm prints, and footprints of dead subjects.
- Recording Major Case Prints (major criminal prints), recording footprints; unusual circumstances- problems ranging from temporary disabilities (e.g., wounds and blisters) to permanent disabilities (e.g., amputated fingers, extra fingers, webbed fingers, arthritis, or palsy)

- Recording postmortem friction ridge detail, decomposition, desiccation (dryness), or maceration (separation and softening of skin by soaking in liquid).
- General recording of recently deceased subjects, recording decomposed friction ridge skin, recording macerated friction ridge skin, recording desiccated friction ridge skin,
- Traditional rehydration method, recording rehydrated friction ridge skin, recording charred friction ridge skin.

Unit-IV: Comparison, Interpretation of fingerprint evidence and courtroom

- Laws and basics in fingerprint identification, Fingerprint Individuality Models.
- Numerical standard and non numerical standard.
- Statistics and probabilities in fingerprint evidence, fingerprint statistical models.
- Limitations and errors in current fingerprint examination process.
- Definition of expert, qualifications and knowledge, expert testimony and forensic reports.
- Case studies.

Reading material:

1. Stephen P Kasper, Latent Processing Guide, Elsevier, UK, 2016.
2. Hilary Moses Daluz, Fundamentals of Forensic Analysis, CRC Press, 2015.
3. Stephen M. Bleay, Ruth S. Croxton, Marcel De Puit, Fingerprint Development Techniques: Theory and Application, Wiley, 2018.
4. Lee and Gaensslen's Advances in Fingerprint Technology, Third Edition (2013), CRC press.
5. E. Roland Menzel, Fingerprint Detection with Lasers, Second Edition, Marcel Dekker, 1999.
6. Advances in Fingerprint technology, Edited by Henry C lee, Robert Ramotowski and R.E Gaensslen, CRC press 2001.
7. Postmortem fingerprinting and unidentified human remains, Marzena Mulawka , Larry S. Miller.
8. Methods of performing postmortem , North Carolina Board of Health.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER-IV (Theory Paper)

PSFSQ403: Forensic Ballistics and Tool Marks Evidence

Hours per week – 04

Credits – 04

UNIT –I: Firearms

Primitive, muzzle loaded, modern firearms, shotgun: Shotgun family, barrel, choke and its types, chamber, action. Rifles: Barrel, twist, barrel calibre and length, action, magazine and stock, Indian rifles, assault rifles. Carbine, Revolvers: Barrel, action, solid frame, break frame and side swinger revolvers, Pistols: Action, barrel, magazine. Machine Guns, Sub-machine gun, Air Rifles and Air Pistols, Cattle Gun, Stud Guns, Caseless cartridge firearm, Pest guns, Improvised firearms, Indian ordinance factory firearms.

UNIT –II: Ammunition and firing mechanism

Propellants: Black, smokeless, semi-smokeless and triple-base powders, RDX based propellants. Projectiles: Lead, jacketed, non-lead, armour piercing, tracer, incendiary, boat-tailed and stream-lined bullets, spherical projectiles. Primers, cartridge cases (shells): Shotgun shell and brass shell. Wads, lubricants, fixed ammunitions: Shotgun cartridge, flechettes, rifle cartridge, revolver cartridge, pistol cartridge, blank cartridge, fifle grenade cartridge, consumable cartridge, duplex cartridge, firing mechanism.

UNIT –III: Evidentiary clues and evaluation

Location: Scene of occurrence, victim, culprit, firearm, ammunition. Collection: Firearm, cartridge case, bullet, slugs and shot, clothes, live ammunition, glass fragments, gun shot residue, injuries, bullet marks and holes, test exhibits. Problems: Firearm, fired ammunition, medico-legal, muzzle-loaders, live ammunition. Acceptability: Relevancy, identity, purity, authenticity, chain of possession. Evidence charts: Evidence information chart, evidence collection log. Forwarding letter, laboratory work and report proforma. Arm-ammunition linkage: Principles, test exhibits, examination, range of fire, GSR (nature, location, detection, collection and evaluation), Injuries (Firearm injuries, shotgun injuries and rifled firearm injuries).

UNIT –IV: Tool Marks Evidence

Importance, types of tool marks, nature, location, collection, methods of comparison, results of comparison, evaluation and limitations of tool marks evidence. Relevant case studies.

Reading Material:

1. Firearms in Criminal Investigation and Trials, 4th Edition, B. R. Sharma, Universal Law Publication, New Delhi.

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

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER-IV (Theory Paper)

PSFSQ404: Physical Evidence Examination

Hours per week – 04

Credits – 04

UNIT –I: Glass and paint examination

Glass: Overview of composition and types of glass, glass breaking mechanism. Primary examination (appearance, colour, fluorescence, surface features, edge thickness, curvature, physical fit), density measurements for bigger fragments of glass, glass fragment density comparison (by flotation method, density gradient tubes). Density range of common glass. Glass refractive index (R.I) ranges of various glass, R.I. measurement of glass: using Immersion methods (becke line concept), using mixture of miscible liquids, using hot stage microscope, Emmons Double Variation and Automated method. Forensic significance of elemental variation in glass and elemental analysis of glass fragments by ICP-MS/LA-ICP-MS.

Paint: Components of paint (binder, solvent, pigment and additives). Microscopic examination (physical matching, matching of layers, examination of surface markings, pigment distribution). micro chemical tests, additional instrumental techniques for identification of paints (Infra-red spectroscopy, X-ray Diffraction, Pyrolysis Gas Chromatography, elemental analysis of the pigments).

UNIT –II: Soil and cement examination

Soil: Microscopic examination (colour, size and shape), microscopical observation with chemical reagents, particle size distribution, ignition test, density distribution of soil particles, pH measurement of soil, examination of soil using X-Ray Diffraction.

Cement: Adulteration in cement- bromoform test, fineness test, ignition test, analysis of insoluble residue, compressive strength test (determination of standard consistency, preparation of cube and determination of compressive strength); examination of cement samples and identification of adulterated cement using X-Ray Diffraction.

UNIT –III: Miscellaneous evidence examination

Broken objects examination (bone, bamboo, lathi, nail, tooth, piece of skin, tool, glass, wooden piece, leaf, clothes, ornament, machinery, pipe, wire, paper sheet, pages from a book, newspaper etc.): Mechanical fit and side by side match.

Electrical cables/wires: Physical properties-number of strands, diameter of strand, dye marks, material, twist, color thickness and marks on insulation.

Tampered electric energy meters: Meter seal and seal wire examination, hole made on the top of meter body or slit made on meter body (in case of analogue meters), front glass removed and reattached, understanding the circuit mechanism of electric energy meter and modifications made for tampering the digital meters.

Fiber: Fiber type and color, number of fibers, fabric type; methods of examination: Physical match, microscopic and visible spectroscopic examination of textile fibers, Thin-Layer Chromatographic examination of Non-reactive dyes in textile fibers, Infrared analysis of textile fibers.

UNIT –IV: Restoration of identification marks

Principle of restoration of marks/numbers, types of identification marks, methods used to obliterate identification marks, chemical etching method for restoration: Preliminary examination, preparation of surface. Etching procedures on different surfaces: 1. Steel surfaces (chassis and engine of cars, guns, gas cylinders etc.), 2. Copper, brass, german silver and other copper alloys, 3. Stainless steel, 4. Lead (motor car batteries etc.), 5. Zinc alloys, 6. Cast iron and cast steel, 7. Aluminum alloys (engine surface of motor bikes, auto-rickshaw engine, vehicle identification plates, etc.), 8. Tin, 9. Gold and Platinum, 10. Wood (punched marks), 11. Leather, 12. Rubber, 13. Polymers. Preservation of the restored punched and engraved marks.

Reading Material:

1. Working procedures Laboratory Manual (Physics Division), DFSL, Mumbai.
2. Forensic Science in Criminal Investigation & Court Evidence, V.N. Sehgal, Selective & Scientific Books, New Delhi.
3. Beveridge, A. D. and Semen, C. Glass density measurement using a calculating digital density meter, *Canadian Society of Forensic Science Journal* (1979) 12(3):113-116.
4. Kirk, P. L. *Density and Refractive Index: Their Application in Criminal Identification*. American Lecture Series. Publication 112. American Lectures in Public Protection. Thomas, Springfield, Illinois, 1951.
5. Koons, R. D., Buscaglia, J., Bottrell, M., and Miller, E. T. Forensic glass comparisons. In: *Forensic Science Handbook*. 2nd ed. R. Saferstein, ed. Prentice-Hall, Upper Saddle River, New Jersey, 2002, Volume 1, pp.161-213.
6. Stoney, D. A. and Thornton, J. I. The forensic significance of the correlation of density and refractive index in glass evidence, *Forensic Science International* (1985) 29:147-157.
7. Elemental Analysis of Glass Fragments by ICP-MS as Evidence of Association: Analysis of a Case, *Shirly Montero et al, J Forensic Sci*, September 2003, Vol. 48, No. 5
8. Forensic Glass Analysis by LA-ICP-MS: Assessing the Feasibility of Correlating Windshield Composition and Supplier, Abbeyle J. Dodds, Edward M. Pollock and Donald P. Land , Report submitted to the U.S. Department of Justice.
9. Review Article - Forensic Glass Comparison: Background Information Used in Data Interpretation-, Maureen C. Bottrell, *Forensic Science Communication*, April 2009, Vol 11, No 2.
10. Soil: Forensic Analysis, Wiley Encyclopedia of Forensic Science, John Wiley and Sons.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER-IV (Lab Course)

PSFSQ P401: Lab Course -7

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)
1. Comparison of glass samples on the basis of appearance, color, fluorescence, surface features, edge thickness, curvature and physical fit.
2. Density measurements of bigger fragments of glass.
3. Density comparison of glass samples by density gradient tubes.
4. Density comparison of glass samples by flotation method.
5. Refractive Index measurement of glass by immersion method.
6. Refractive index of glass using hot stage microscope.
7. Microscopic examination of soil.
8. Ignition test for soil.
9. pH measurement of soil samples.
10. Particle Size Distribution of soil samples.
11. Density distribution of soil particles.
12. Examination of soil samples using X-Ray Diffraction.
13. Testing cement sample for adulteration.
14. Fineness test of cement.
15. Ignition test of cement.
16. Examination of cement samples using X-Ray Diffraction.
17. Microscopic examination of paint samples.
18. Microchemical testing of paint samples.
19. Paint comparison by FTIR.
20. Examination of broken objects.
21. Examination of electric wires.
22. Examination of cut-marks on metallic wires/objects.
23. Examination of tampered electric energy meter.
24. Examination of fabric.
25. Examination of cut-marks/tear marks on clothes.
26. Examination of tool marks.
27. Study of calibre and rifling characteristics.
28. Examination of firearms.
29. Examination of bullets.
30. GSR analysis.
31. Restoration of marks/numbers on various surfaces.

M. Sc. FORENSIC SCIENCE
(Questioned Documents, Finger prints and Forensic Physics)
SEMESTER-IV (Lab Course)

PSFSQ P402: Project

Hours per week – 08

Credits – 04

Project will be compulsory to all students. Students will carry out project work individually. Concerned department shall provide all required infrastructure to carry out project work. The format for project report will be similar to the research thesis style; incorporating chapters on: Introduction, Review of Literature, Materials and Methods, Results and Discussion and References / Bibliography. The project report will be submitted in a typewritten and bound form. Students will present their work for evaluation. Copy of each project report will be submitted to the respective department. Project work on forensically significant and need based problems in the area of Questioned Documents, Finger prints and Forensic Physics and other forensically important topics as per local, regional, national and international need.

Syllabus for

M. Sc.

Forensic Science

Semesters - III & IV

Specialization - 2:

Forensic Chemistry and Toxicology

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-III (Theory Paper)

PSFSC301: Forensic Chemistry - I

Hours per week – 04

Credits – 04

UNIT –I: Introduction to forensic chemistry

- Introduction and scope, types of exhibits received in forensic chemistry division of FSL, role and responsibilities of forensic chemical analyst, tools and techniques used in analysis of exhibits.
- Analytical Forensic Chemistry: Schemes of identification of unknown solids, volumetric/titrimetric methods of analysis, theory of indicators, gravimetric methods of analysis, process of precipitation, saturated and supersaturated solution, methods of sample preparation in organic and inorganic analytical chemistry.

UNIT –II: Analysis of petroleum products

- Petroleum: Origin, composition, refining, reforming, fractionation, cracking, knocking, octane number, cetane number.
- Petroleum products: Introduction and properties.
- Testing of petroleum products: Analysis of petrol, kerosene, diesel and Aviation Turbine Fuel as per BIS/ASTM Specifications- Distillation, density, viscosity, surface tension, color, fluorescence, cloud point, pour point, aniline point, smoke point, boiling point, optical properties, flash point, refractive index and calorific value.
- Analysis of petroleum dyes: Dyes and their types; extraction of dyes and analysis by instruments.
- Analysis of trace amount of petroleum products in exhibits received in FSL.

UNIT –III: Analysis of alcohol

- Liquors: Introduction, classification of commercial liquors/country made/illicit liquor, origin of liquors, geographical demography of Indian handmade liquors.
- Manufacturing of liquors: Fermentation and distillation methods (pot still and continuous still), units of alcohol-proof value of spirit.
- Liquor analysis: Analysis of liquors according to BIS and PFA specifications- detection and determination of ethanol, furfural, organic acids, aldehydes, chloral hydrates, methanol and ethylene glycol by color tests.
- Analysis of ethyl alcohol, methyl alcohol and denaturants in beverages, liquor, biological fluids (blood and urine): Color tests, GC, Headspace-GC and GC-MS methods.
- Breath analyzer: Principle, mechanism, types of breath analyzer, blood-alcohol sample collection and preservation.
- Pharmacokinetics of alcohol: Absorption, distribution, metabolism and excretion of

ethanol, methanol and propanol.

UNIT –IV: Fire chemistry and arson investigation

- Chemistry of fire: Light and flame, triangle of fire, combustion reaction, fire behavior, fire tetrahedron; thermo-chemistry of fire, heat capacity and phase changes, accelerants and types of accelerants, combustible and flammable liquids, flash point, fire point, ignition point, auto ignition point, vapor density, vapor pressure.
- Stages of fire, flashover, back draft; Fire patterns (U & V); determining origin and cause of fire.
- Fire/arson scene investigation: Introduction, degrees of arson, material and chemicals used in initiating arson, examination of scene of arson, recognition and collection of evidences, preservation, packing, labeling and forwarding of exhibits.
- Analysis of fire/arson debris: Extraction of ignitable liquid residues from fire debris by different methods-Direct and solvent extraction, distillation, Head Space, SPME, followed by Clean-up methods-Filtration and acid stripping and analysis by instruments-GC-DHA, GC-MS, Head-space GC, FTIR and SEM; Interpretation of spectra in case of arson.

Reading Material:

1. Mathew E. Johl (2009) Investigating Chemistry: A Forensic Science Perspective
Saferstein (1976) Criminalistics.
2. Saferstien: Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA
Yinon Jitrin (1993)
3. Modern Methods & Application in Analysis of Explosives, John Wiley & Sons ,England
16) J A Siegel, P.J Saukko (2000)
4. Encyclopedia of Forensic Sciences Vol. I, II and III, Acad. Press.
5. Lundquist & Curry : Methods of Forensic Science, 1963.
6. Walb & Brounds : Drunks, Drugs & Driving.
7. Hoffman : A Handbook on Drug Alcoholic Abuse.
8. Maehly and Stromberg : Chemical Criminalistics, 1980.
9. Carvey R.H & Baselt R.C; “Introduction to Forensic Toxicology and Biochemicals”,
Publ. Davis C.A, 1981.
10. Moffat, A.C. (Editor) : Clark’s Isolation and Identification of Drugs, 1996.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-III (Theory Paper)

PSFSC302: Forensic Examination of Drugs

Hours per week – 04

Credits – 04

UNIT –I: Drugs of abuse

- Introduction to drug of abuse; drug dependence, drug addiction and its problems.
- Classification of drug of abuse: depressant, stimulant and hallucinogen; Depressants: opium and opioids, barbiturates and benzodiazepines; Stimulants: cocaine, nicotine and amphetamines; Hallucinogens: cannabis and its derivatives, phencyclidine and LSD.
- Status of drug abuse in India; introduction to club drugs, designer drugs and date rape drugs.
- Solvent abuse: Introduction, use and abuse, addiction, route of administration, sampling and extraction in case of poisoning, chemical and instrumental analysis.

UNIT –II: Clandestine laboratory investigation and related laws

- Clandestine drug manufacture: lab operators, manufacturing process, clandestine lab need triangle.
- Clandestine lab hazards: general hazards, priority hazards-explosions, fire, firearm, exposure; dealing with hazards at clandestine lab site.
- Scene processing: training, seizure stages, planning, documentation, search, sampling, field testing, disposal
- Lab analysis: inorganic and organic compounds-color tests, microscopic analysis, IR spectroscopy, Ion chromatography, X-ray, Mass spectroscopy, GC, HPLC.
- Narcotic Drugs and Psychotropic Substances Act, 1985: Definitions: addict, narcotic drug, manufactured drug, medicinal cannabis, coca plant, cannabis plant, opium, poppy straw, opium poppy, psychotropic substance, controlled substance, illicit traffic; authorities and officers; prohibition, control and regulation; offences and penalties: commercial and small quantity, consumption of NDPS, repetitive offence, death penalty; procedure; miscellaneous.

UNIT –III: Drugs of abuse in sports

- Introduction, International Olympic Committee (IOC), World Anti-Doping Agency (WADA), doping control policies and operational guidelines.
- Prohibited substances in and out of competition; prohibited methods; prohibited substances in particular sports (alcohol and beta blockers).
- Sampling techniques and identification of sport drugs by various instruments such as GC, GC-MS, and HPLC.

UNIT –IV: Analysis of drugs

- Methods of extraction of drug (acidic, basic and neutral) from biological matrices such as blood, urine, saliva, vomit, viscera.
- Preliminary analysis of drugs: Identification of drugs by spot tests, microcrystal tests, TLC and UV-Vis spectroscopy.
- Confirmatory analysis of drugs: Quantification of drugs by FTIR, GC, HPLC, GC-MS, LC-MS/MS, NMR and XRD.

Reading Material:

1. Methods of Pesticides Analysis by Shree Ramulu.
2. R.Clemlyn : Pesticides.
3. K.H.Buchel Chemistry of Pesticide.
4. Curry A.S ; Analytical Methods in Human Toxicology : Part II ,CRC Press Ohio, 1986.
5. Clark E.G.C; Isolation and Identification of drugs, Academic Press, London, 1986
6. Sunshine I : Handbook of Analytical Toxicology, CRC Press, Costa Rica,1969.
7. Saferstein, R (1982) Forensic Science Hand Book, Vol I, II and III, Prentice Hall, NJ.
8. Suzanne Bell (2009) Drugs, Poisons, and Chemistry.
9. DFS Manuals of Forensic Chemistry and Narcotics.
10. Paranjape, H.M., Bothara, G.K., Jain, M.M; “Fundamentals of Pharmacology”, 1st edition, Nirali Prakashan, 1990.
11. 16. Budhiraja, R.D; “Elementary Pharmacology and Toxicology”, Popular Prakashan, 2nd edition, 1999.
12. 17. Hardman, J. G. and Limbird, L.E; “Goodman and Gilman”s The Pharmacological Basis of Therapeutics”, 9th edition, McGraw-Hill, 1996
13. 18. Moffat, A.C, Osselton, D. M, Widdop, B; “Clarke”s Analysis of Drugs and Poisons in Pharmaceuticals, body fluids and postmortem material”, 3rd edition, Pharmaceutical Press, 2004.
14. Modi, JP, Textbook of Medical Jurisprudence & Toxicology, N.M. Tripathi Pub,2001.
15. Parikh, C.K; Text Book of Medical Jurisprudence, Forensic Medicine & Toxicology, CBS Pub. New Delhi,1999.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-III (Theory Paper)

PSFSC303: Modern Instrumental Technique - I

Hours per week – 04

Credits – 04

UNIT –I: Spectral techniques

- Mass Spectroscopy: Introduction, principle, instrumentation and working; ionisation methods, mass to charge ratio; types of mass spectroscopy; Fragmentation of selected functional groups, interpretation of mass spectra, forensic applications.
- Fluorescence and phosphorescence spectroscopy: Principle, types of sources, structural factors, instrumentation, comparison of luminescence and UV-visible absorption methods, applications.

UNIT –II: Separation techniques

- Size Exclusion Chromatography: Introduction, theory, instrumentation, gel permeation, retention behavior, determination of molecular weight of polymer and other applications.
- Super Critical Fluid Chromatography: Introduction, theory, principle, instrumentation, and applications.
- Inverse Gas Chromatography: Introduction, principle, theory, instrumentation, applications.
- Affinity Chromatography: Introduction, theory, instrumentation and applications.

UNIT –III: Thermal methods of analysis

- Thermo gravimetric Analysis (TGA): Introduction, types of thermal analysis, thermo gravimetric curve, instrumentation, working, TGA curves, factors affecting TGA, applications.
- Differential Thermal Analysis (DTA): Introduction, instrumentation, principle of working, DTA curves, factors affecting DTA, applications.
- Thermometric Titrations: Introduction, theory, instrumentation, techniques of thermo gravimetric titrations, applications.

UNIT –IV: Radio analytical Techniques

- Radio analytical Techniques: Introduction, principle and theory, preparation of some commonly used radioisotopes, uses of radioisotopes, and industrial applications; Introduction to nuclear forensics, nuclear threats, nuclear explosive devices, radioactivity, radioactive decay rates and half lives; methods of detection and measurement of radioactives (G.M and Scintillation Counter); applications of radioisotopes.
- Neutron Activation Analysis: Principle, theory, instrumentation and applications.
- Radiometric Titrations: Principle, instrumentation, merits, demerits and applications.

- Carbon Dating, Radio Chromatography.
- Isotope dilution analysis: Principle, types of isotope dilution analysis, typical applications of isotope dilution analysis.

Reading Material:

1. A Textbook of Pharmaceutical Analysis (Instrumental Methods), Vol-2, Nirali Prakashan by Dr. A.V. Kasture, Dr. K.R. Mahadik, Dr. S.G. Wadodkar & Dr. H.N. More (pg. 169-168, 207-221). (pg. 169-168, 207-221). (pg. 18-30, 48-57, 58-75). (pg. 258-263)
2. Instrumental Methods of Chemical Analysis, Ed. 3, Pragati Prakashan by Dr. H. Kaur (pg. 814-825, 798-813, 826-841).(pg. 737-747, 748-755, 756-760). (pg. 946-965, 939-945).
3. P.S. Kalsi, Organic spectroscopy
4. Y.R. Sharma, Organic spectroscopy.
5. W. Kemp, Organic spectroscopy.
6. Introduction to Instrumental Analysis By R.D.Broun, Mc.Graw Hill (1987)
7. Principle Of Activation Analysis By P.Kruger, John Wiley and sons (1971)
8. Nuclear Analytical Chemistry By J.Tolgyessy and S.Verga vol. 2
9. Radiochemistry and Nuclear Methods By W.D. Ehmann and D.E. Vance, John Wiley
10. Vogel Textbook of quantitative analysis.
11. Extraction Chromatography T.Braun, G. Ghersene, Elsevier Publications 1978.
12. Super Critical Fluid Extraction Larry Taylor Wiley publishers N.Y. 1996.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-III (Theory Paper)

PSFSC304: Forensic Toxicology – I

Hours per week – 04

Credits – 04

UNIT –I: Introduction to Forensic Toxicology

- Introduction and scope of Forensic Toxicology, development of forensic toxicology.
- Classification of poisons based on their symptoms; nature of poisoning: accidental, homicidal, suicidal and miscellaneous; routes of administration and elimination of poisons.
- Action of poisons: local, remote, systemic, general; causes modifying action of poisons: quantity, form, mode of administration, condition of body.
- Diagnosis of poisoning in living and the dead; poisoning in view of Indian scenario.
- Treatment in cases of poisoning: removal of unabsorbed poison, use of antidotes, elimination of poison, treatment of general symptoms.
- Collection, handling and preservation of viscera, blood, urine and other biological fluids in poisoning cases, submission of samples into the laboratory, examination of viscera and biological fluids, interpretation of toxicological findings and preparation of reports.
- Limitation of methods and trouble shooting in toxicological analysis, disposal of unused samples pertaining to toxicological analysis.

UNIT –II: Extraction methods

- Extraction: Introduction and fundamental principles of extraction.
- Classical approach for aqueous extraction: Introduction, Liquid-Liquid extraction (LLE) (theory of LLE, selection of solvents, solvent extraction).
- Solid Phase extraction (SPE): Introduction, types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, Automation and On-Line SPE.
- Solid phase micro-extraction: Introduction, theoretical considerations, experimental, Methods of analysis: SPME-GC and SPME-HPLC-MS, Automation of SPME.
- Solid-liquid extraction: Introduction, soxhlet extraction, sonication, shake-flask extraction, soxtec extraction.
- Microwave assisted extraction: Introduction, instrumentation, forensic applications.
- Supercritical Fluid Extraction: Introduction, instrumentation, forensic applications.

UNIT –III: Corrosive poisons

- Introduction, signs and symptoms, fatal dose, fatal period and postmortem appearance of the following:
 - Inorganic acids: Sulphuric acid, nitric acid, hydrochloric acid, hydrofluoric acid, boric acid.
 - Organic acids: oxalic acid, carbolic acid, salicylic acid, acetic acid, formic acid
 - Alkalies: ammonia, sodium hydroxide, potassium hydroxide
- Extraction of acid and alkalies from various biological matrices and their identification and quantification.

UNIT –IV: Irritant poisons

- Introduction, signs and symptoms, fatal dose, fatal period and postmortem appearance of the following:
 - Non-metallic poisons: Phosphorus, chlorine, iodine, bromine
 - Metallic poisons: Arsenic, antimony, bismuth, mercury, copper, lead, aluminium, silver, zinc
- Extraction and isolation of metallic poisons from various biological matrices by dry ashing, wet digestion and microwave digestion methods and their subsequent identification by Reinsch's test, Gutzeit Test and instrumental techniques.
- Extraction of non-metallic poisons from biological matrices by dialysis method and their identification using color tests and other methods.

Reading Material:

1. Modi's Medical Jurisprudence and Toxicology-23rd Ed. Publisher-Lexis Nexis Butterworths Wadhwa.
2. Parikh's Textbook of Medical Jurisprudence, Forensic medicine and Toxicology- C.K. Parikh, CBS Publishers and Distributors.6th Ed.
3. John R. Dean, Extraction techniques in analytical sciences, John Wiley & Sons.
4. A TEXTBOOK OF MODERN TOXICOLOGY by Ernest Hodgson
5. Anil Aggrawal, Essentials of forensic medicine and toxicology, Avichal publishing company.
6. Casarett & Doll Toxicology, The basic Science of Poisons.
7. DFS Manual Forensic Toxicology.
8. Clark, E.G.C.; Isolation and Identification of Drugs, Vol. I and Vol. II, Academic Press, (1986).
9. Lange's Basic and Clinical Pharmacology, 10th Ed. (2007) by Bertram G. Katzung, McGraw-Hill Publishers, Pg. (934-943).

10. Text book of Micro chemistry of poisons including their physiological, pathological and legal relation.-Theodore George Wormley: Internet ref: book.google.co.in.
11. Sunshine I; Year book of Toxicology, CRC Press Series, USA (1989 – 93).
12. Michael J. Deverlanko et al: Hand Book of Toxicology CRC Press, USA (1995).
13. Prakash M. et al; Methods in Toxicology Anmol Publication, New Delhi (1998).
14. Balraj S. Parmar et al; Pesticide Formulation, CBS Publishers, New Delhi (2004).
15. Reiss C et al; Advance in Molecular Toxicology, Utrecht, Netherlands (1998).
16. Morgan B.J.T; Statistics in Toxicology, Clarendon Press, Oxford (1996).
17. Jorg Rombke et al; Applied & Ecotoxicology Lewis publishers NY (1995).
18. Shayne C.Gad et al; Acute Toxicology Testing Academic Press California USA (1998).
19. Chadha PV; Hand Book of Forensic Medicine and Toxicology, Jaypee Brothers New Delhi (2004) Semester-II FS-10832.
20. Turner Paul; Recent Advances in Pharmacology & Toxicology, Churchill Livingstone, Elenburgh (1989).
21. Chadha PV; Hand Book of Forensic Medicine and Toxicology, Jaypee Brothers New Delhi (2004) Semester-II FS-10832.
22. Cravey R.H, Baselt, R.C; Introduction to Forensic Toxicology, Biochemical Pub. Davis C A (1981).
23. S. N. Tiwari, Analytical Toxicology, Govt. of India publications, New Delhi 1987.
24. Willard H. H. et. al : Instrumental Methods of Analysis 1974.
25. Moonesens A. A. et. al. : Scientific Evidence in Criminal Cases 1973.
26. Lundquist and Curry: Methods of Forensic Sciences 1963.
27. Arena Poisoning, Chemistry Symptoms and treatment.
28. Analysis of Plant Poisons, Dr. M P Goutam.
29. Drug Abuse Handbook, Karch.s.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-III (Lab Course)

PSFSC P301: Lab Course -5

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Analysis of petroleum products by density, viscosity and distillation.
2. Analysis of petroleum products by flash point, GC-DHA, HPTLC.
3. MP, BP and flash point determination of petroleum products.
4. Analysis of dye in petrol by UV-Visible spectroscopy.
5. Distillation characteristics of gasoline, kerosene and diesel.
6. Analysis of alcoholic liquor as per BIS specifications.
7. Determination of methanol and ethanol in alcoholic liquors.
8. Chemical analysis of liquors.
9. Determination of percentage of proof spirit of ethyl alcohol in illicit liquor.
10. Qualitative and quantitative analysis of ethyl alcohol from blood/urine samples using classical and instrumental methods.
11. Chemical analysis of arson evidence.
12. Forensic analysis of arson related evidence.
13. Extraction and detection of petrol, kerosene, diesel in fire debris by TLC.
14. Systematic identification of narcotic drug and psychotropic substances by color and microcrystalline test.
15. Identification of drugs of abuse by TLC.
16. Extraction and identification of acidic drugs from biological matrices.
17. Extraction and identification of basic drugs from biological matrices.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-III(Lab Course)

PSFSC P302: Lab Course -6

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Systematic identification of narcotic drugs and psychotropic substances (opiates, cannabis and barbiturates, benzodiazepines and amphetamines) by colour tests and TLC.
2. UV/Visible spectrometric analysis of NDPS.
3. Analysis of NDPS by HPLC.
4. TLC separation of anabolic steroids.
5. Analysis of pharmaceutical sample by UV, FT-IR and NMR spectroscopy.
6. Analysis of charas and ganja by GC-MS and HPLC techniques.
7. Detection and identification of ammonium drugs and poison in pharmaceutical preparation by colour test and instrumental technique.
8. Analysis of blood, urine, stomach wash in emergency cases of poisoning.
9. Analysis of corrosive chemicals: HCl, H₂SO₄, HNO₃.
10. Analysis of corrosive chemicals: alkalis.
11. Systematic analysis of viscera and blood in case of poisoning.
12. Extraction of poisons from hair samples.
13. Extraction and identification of metallic poisons from viscera using dry ashing method followed by reinsch test.
14. Detection of metallic poisons in food stuff.
15. Systematic analysis of metal poisons as per IPC specification by using HPLC, ICP-OES, AAS.
16. Determination of mercury and lead in plant or animal derived materials by spectrophotometry.
17. Determination of nickel in biological materials by colorimetric/spectrophotometric method.
18. Analysis of non-metallic (anions) poisons in viscera.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-IV (Theory Paper)

PSFSC401: Forensic Chemistry - II

Hours per week – 04

Credits – 04

UNIT –I: Explosives

- Explosives: Introduction, classification, synthesis and chemistry of explosives; deflagration and detonation phenomenon (redox chemistry, kinetics-molecular theory of gases and gas laws), explosion process, characteristics of high and low explosives, dust explosion, gas/vapor explosion, BLEVE, effect of blast wave on structures and human; pyrotechnics.
- Improvised Explosive Device (IED): Definition, components; explosives initiation (explosive trains); Types of IED- Molotov cocktail, Letter bomb, Pipe bomb, VBIED and CBRN;
- Detection of hidden explosives.

UNIT –II: Forensic examination of explosives

- Scene of explosion: Specific approach to scene of explosion, reconstruction of sequence of events, evaluation and assessment of scene of explosion, Protocol for first responders, objectives at blast scene, outside investigation (securing scene, search for suspect, etc.), on-site (inside) investigation: leading, recording, searching, collecting of post blast residue (low and high explosive residues, device components) and preserving.
- Analysis of explosive residues: Systematic examination of explosive residues in the laboratory; method of sample preparation-extraction, distillation; chemical analysis-color tests, volumetric methods; analysis by instruments-chromatographic analysis (TLC, GC, HPLC), spectroscopic analysis (FT-IR, GC-MS, XRD).

UNIT –III: Forensic examination of fertilizers, oil/fats and chemical warfare agents

- Fertilizers: Introduction, classification and types of fertilizers; NPK value, chemical composition of nitrogenous and phosphate fertilizers.
- Analysis of Fertilizers: Sampling methods, chemical and instrumental methods of analysis.
- Analysis of oil and fats: Physical characteristics of oils/fats (moisture, specific gravity, refractive index, melting point); chemical characteristics of oils/fats (acid value, saponification value, ester value, acetyl value, iodine value); chemical tests for detection of adulteration in oils/fats by color test, TLC, UV-Visible spectroscopy, HPLC and FTIR.
- Chemical warfare agents: Introduction, classification, physical and chemical properties, toxic effects; analysis of chemical warfare agents by various instrumental techniques.

UNIT –IV: Forensic examination of trap cases, spurious jewellery and cosmetics

- Trap cases: Introduction, trap chemicals: phenolphthalein and anthracene; mechanism of color reaction; factor affecting the color; detection of phenolphthalein and alkali; method of detection of degraded product of phenolphthalein by TLC and UV visible spectrophotometer; forensic significance.
- Examination of spurious jewellery in cheating cases: Introduction, purity of metals including precious metals such as gold, silver and platinum; different types of metals commonly encountered for forensic analysis, hall marking of precious metal according to BIS.
- Forensic significance of cosmetics: Introduction, types of forensic relevant cosmetic products, composition of cosmetics-chemistry of colorants, dyes, pigments and polymers; analysis of cosmetic evidence by various instruments.

Reading Material:

1. B.R.Sharma,Forensic science in criminal investigation and trials.4th Ed.(P.858-902)
2. Forensic science in criminal investigation and trials(p.858-902)
3. Dr.R. Krushanamurti, Forensic science in crime investigation.
4. B.S.Nabar, Forensic science in crime investigation.
5. James E.Girad, Criminalistics, Forensic science in crime.
6. Dr.M.S.Rao, Dr.B.P.Maithil, K.V.Ravikumar, Crime scene management(p.162,264).
7. M.Chatterjee and R.Shinde, Text book of medical biochemistry, 6th Ed., Jypee publication.
8. Michael M,Cox,David L,Nelson.,Lehninger Principles of biochemistry.
9. Bergmeyer, Methods of enzymatic analysis.
10. Chadha PV; Hand Book of Forensic Medicine and Toxicology, Jaypee Brothers New Delhi (2004) Semester-II FS-10832.
11. Turner Paul; Recent Advances in Pharmacology & Toxicology, Churchill Livingstone, Elenburgh (1989).
12. Cravey R.H, Baselt, R.C; Introduction to Forensic Toxicology, Biochemical Pub. Davis C A (1981).
13. Working Procedure Manual - Toxicology, BPR&D Publication (2000).
14. Ballantyne B; General and Applied Toxicology Vol-1-3 2nd Ed., Macmillan, NY (2000).
15. Gossel T.A; Principles of Clinical Toxicology 3rd Ed., Roven, NY (1994).
16. Grossel S S; Handbook of Highly Toxic Materials handling and Management, Marcel Dekker NY (1995).
17. Niesink RJM; Toxicology- Principles and Applications, CRC Press (1996).
18. Quantitative inorganic analysis; Vogel.
19. Organic Electronic spectral data; Vol.-I; Mortiman Kamlet.

20. Organic Electronic spectral data; Vol.-III; Mortiman Kamlet.
21. Inorganic Semi micro qualitative analysis; Griffin & Plunky.
22. Peerson's Chem. Analysis of food; H.Egan, Kirk.
23. Vogel's Book of Macro & Semi micro qualitative inorganic Analysis; G.Svehla.
24. Explosive (4th Rev.Ed); J.Kohler, Redolf.
25. Clerk's Analysis of Drugs & Poisons VOL.-I & II; Clerk.
26. Development & Validation of Analytical Methods; Christopher, M.Riley, Thomas W.
27. Scientific protocols for fire investigation; John J. Lentini.
28. Steroid analysis by HPLC; Marie P. Kautsky.
29. TLC VOL.-II; Jork, Funk & Others.
30. Settle F. A.: Handbook of Instrumental Technique for Analytical Chemistry, Prentice Hall 1997.
31. Borrow: Molecular Spectroscopy 1980.
32. Willard H. H. et. al : Instrumental Methods of Analysis 1974.
33. Moonesens A. A. et. al. : Scientific Evidence in Criminal Cases 1973.
34. Lundquist and Curry: Methods of Forensic Sciences 1963.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-IV (Theory Paper)

PSFSC402: Forensic Pharmacology

Hours per week – 04

Credits – 04

UNIT –I: Pharmacology and Forensic Pharmacology

- Introduction to pharmacology, divisions of pharmacology, drug nomenclature.
- Routes of drug administration.
- Pharmacopoeias IP, USP, EP.
- Introduction to Forensic Pharmacology.
- Specimen collection procedures: Blood, urine, bile, vitreous humor, gastric contents, liver, stomach, kidney, intestines, brain, lungs, spleen, hair, sweat, saliva, skin, muscle.
- Post mortem drug redistribution.

UNIT –II: Pharmacokinetics

- Pharmacokinetics: drug absorption, distribution, metabolism and excretion of drugs (ADME).
- Pharmacokinetics parameters evaluation: dosage, concentration, clearance, disappearance, volume of distribution, bioavailability, half-life.
- Drug absorption: Organization of biological membrane, transportation of drug molecules across biological membranes, factors affecting absorption.
- Drug distribution, factors affecting drug distribution.
- Drug metabolism/Biotransformation: Phase-I and Phase-II reactions; First pass metabolism; detection of poison on the basis of their metabolic studies.
- Drug excretion: Excretion of drugs by renal, faeces, exhaled air, saliva, sweat, milk, skin, and bile.
- Time course of drug plasma concentrations after single and repeated administrations.
- Therapeutic drug monitoring.

UNIT –III: Pharmacodynamics

- Principles of drug action; sites and mechanisms of action of drugs-enzymes, ion channels, transporters, receptors; receptor classification, drug-receptor interactions and signal transduction mechanisms;
- Dose-response relationship; agonists, partial agonists and antagonists; factors that modify drug actions; side effects, overdose, idiosyncratic and allergic reactions; teratogenesis and fetal toxicity; variability of drug effects: factors depending on the drug, on the patient, on the treatment schedule; drug interactions.
- Drug interactions like agonism, antagonism, addition, synergism, potentiation.

- Adverse drug effects, classification of adverse reactions (type A, B, C, D and E).

UNIT –IV: Pharmacology of forensic relevant drugs

- Classification, source, pharmacokinetics, duration of action, mechanism of action, pharmacological actions and toxicology of the following drugs:
 - Stimulants, such as, amphetamines, cocaine.
 - Benzodiazepines, such as, diazepam.
 - Hallucinogens, such as, cannabis.
 - Opioids, such as, morphine.
 - Ethanol.

Reading Material:

1. Klaassen, C. D., Casarett and Doull's Toxicology: The Basic Science of Poisons, 5th ed, McGraw-Hill, 1995.
2. Moffat, A.C. : Osselton, D. M. Widdop, B. : Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, body fluids and postmortem material, 3rd ed., Pharmaceutical Press 2004.
3. Bogusz, M. J.,: Hand Book of Analytical Separations, Vol. 2: Forensic Science, 1st ed., Elsevier Science ,2000.
4. Siegel, J.A., Saukko, P. J., Knupfer, G.,: Encyclopedia of Forensic Sciences (Vol3), Academic Press, 2000.
5. Rang, P.H., Dale, M.M., Ritter, M.J.: Pharmacology, 4th ed., Harcourt/Churchill Livingstone, 2000.
6. Paranjape, H.M., Bothara, G.K., Jain, M.M.: Fundamentals of Pharmacology, 1st ed., Nirali Prakashan, 1990.
7. Budhiraja, R.D.: Elementary Pharmacology and Toxicology, Popular Prakashan, 2nd ed., 1999.
8. Wiseman, H and Henry J.: Management Of Poisoning, A Handbook for Healthcare workers, 1st ed., A.I.T.B.S, 2002 .
9. Hardman, J. G. and Limbird, L. E.,: Goodman and Gilman's The Pharmacological basis of Therapeutics, 9th ed., McGraw-Hill, 1996 .
10. Laboratory procedure Manual, Forensic Toxicology: DFS, 2005 .
11. Sunshine, I ; Methods for Analytical Toxicology, CRC Press USA (1975)
12. Cravey, R.H; Baselt, R.C.: Introduction to Forensic Toxicology , Biochemical Publications, Davis, C.A. (1981)
13. Stolmen, A.; Progress in Chemical Toxicology: Academic Press, New York (1963)
14. Modi, Jaisingh, P.; Textbook of Medical Jurisprudence & Toxicology, M.M. Tripathi Publication (2001)
15. Eckert; An Introduction to Forensic Science, CRC Press.
16. Pillay, V. V.; Handbook of Forensic Medicine and Toxicology, Paras Pub., 2001.

17. Curry, A. S: Poison Detection in Human Organ.
18. James, S. H. and Nordby, J. J.: Forensic Science: An Introduction to Scientific and Investigative Techniques, 2003.
19. Saferstein, R: Criminalistics - An Introduction to Forensic Science, Prentice Hall, 1995.
20. Sarkar, S: Fuels and Combustion, Orient Longman, 1990.
21. Verma, R. M: Analytical Chemistry – Theory and Practice, CBS Pub., 1994.
22. Svehla, G. Ed.: Vogel's Qualitative Inorganic Analysis, Longman, 1998.
23. Bassett: Vogel's Text Book of Quantitative Inorganic Analysis, Longman, 1978.
24. Vogel, A. I: Text Book of Practical Organic Chemistry including Qualitative Organic Analysis, ELBS, 1971.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-IV (Theory Paper)

PSFSC403: Modern Instrumental Technique – II

Hours per week – 04

Credits – 04

<p>UNIT –I: Spectral techniques</p> <ul style="list-style-type: none"> • Raman spectroscopy: Principle, theory, instrumentation, sample handling and illumination, structural analysis, dispersive & FT analysis, forensic applications. • X-ray Spectroscopy: X-ray absorption method, X-ray Fluorescence (XRF) and Energy Dispersive-X-ray fluorescence (EDXRF) method, X-ray diffraction, Auger mission spectroscopy (AES), and Electron Spectroscopy for Chemical Analysis (ESCA), forensic applications.
<p>UNIT –II: Separation techniques</p> <ul style="list-style-type: none"> • Electrophoresis: Introduction, principle, types, instrumentation, factors affecting migration of ions, Capillary Electro chromatography (CEC), and forensic applications. • ICP: Introduction, principle, instrumentation, working, forensic applications. • Hyphenated Techniques: ICP-OES, GC-MS, LC-MS.
<p>UNIT –III: Microscopy</p> <ul style="list-style-type: none"> • Microscope: Main parts and functions, types–simple and compound, illumination, condenser, lens, aberrations, eye piece and their types, resolution, magnification, numerical aperture. • Special microscopes: Instrumentation and applications of infra-red microscope, polarizing microscope, phase contrast microscope, fluorescent microscope, electron microscope – SEM and TEM.
<p>UNIT –IV: Miscellaneous techniques</p> <ul style="list-style-type: none"> • Polarography: Introduction, principle, polarographic apparatus and applications. • Amperometry: Introduction, methodology, titration curves and applications. • Measurement of potential and pH: Electrode potential, electrochemical cell, reference electrode, indicator electrode, method of detecting end point.

Reading Material:

1. A Textbook of Pharmaceutical Analysis (Instrumental Methods), Vol-2, Nirali Prakashan by Dr. A.V. Kasture, Dr. K.R. Mahadik, Dr. S.G. Wadodkar & Dr. H.N. More (pg. 169-168, 207-221). (pg. 169-168, 207-221). (pg. 18-30, 48-57, 58-75). (pg. 258-263)

2. Instrumental Methods of Chemical Analysis, Ed. 3, Pragati Prakashan by Dr. H. Kaur (pg. 814-825, 798-813, 826-841).(pg. 737-747, 748-755, 756-760). (pg. 946-965, 939-945).
3. P.S. Kalsi, Organic spectroscopy
4. Y.R. Sharma, Organic spectroscopy.
5. W. Kemp, Organic spectroscopy.
6. Fundamentals of Analytical Chemistry Eighth edition SKOOG, West, Holler, Crouch
7. Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Gurudeep R. Chatwal, Sham K. Anand
8. Instrumental Methods of Analysis Seventh edition, Willard, Merritt, Dean, Settle

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-IV (Theory Paper)

PSFSC404: Forensic Toxicology – II

Hours per week – 04

Credits – 04

UNIT –I: Agricultural poisons

- Classification of agricultural poisons
- Introduction, signs and symptoms, fatal dose, fatal period and postmortem appearance of the following: Organophosphorus, carbamates and organochlorine compounds, pyrethrins and aluminium phosphide.
- Extraction of agricultural poisons from various biological matrices and their subsequent identification using color tests and instrumental techniques.

UNIT –IV: Gaseous and volatile poisons

- Introduction, signs and symptoms, fatal dose, fatal period and postmortem appearance of the following:
 - Gaseous poisons: Carbon dioxide, carbon monoxide, carbon disulphide, hydrogen sulphide, nitrogen monoxide, sulphur dioxide, war gases.
 - Volatile poisons: Acetone, aniline, benzene, chloroform, ethyl alcohol, methyl alcohol, formaldehyde, phenol, acetaldehyde, isopropyl alcohol, hydrocyanic acid
- Extraction of gaseous and volatile poisons from various biological matrices and their subsequent identification using color tests and instrumental techniques.

UNIT –III: Plant poisons

- Introduction, active constituents, signs and symptoms, fatal dose, fatal period, postmortem appearance of the following:
 - Neurotic: Papaver somniferum, Cannabis sativa, Erythroxyton coca, Atropa belladonna, Datura fastuosa, Strychnos nux vomica
 - Cardiac: Nicotiana tabacum, Aconitum napellus, Digitalis purpurea, Cerbera thevetia
 - Irritant: Abrus precatorius, Calotropis gigantea, Croton tiglium, Argemone mexicana, Ricinus communis, Semicarpus anacardium, Plumbago rosea.
- Extraction and stripping of plant poisons from various matrices using stass-otto, modified stass-otto, ammonium sulphate methods, other methods and their subsequent identification using color tests and instrumental techniques.

UNIT –IV: Animal poisons and food poisoning

- Introduction, signs and symptoms, fatal dose, fatal period and postmortem appearance of animal toxins due to the following: Cantharides, scorpion, spiders and poisonous

insects: ants, bees, wasps.

- Snakes: Classification of snakes; snake venom: composition, sign and symptoms, fatal dose, fatal period, postmortem appearance, mode of action; treatment of snake bite and tests for identification.
- Food Poisoning: Classification-biological contaminants (bacteria, viruses, fungus), vegetable origin, animal origin, chemical poisoning, ptomaines, food allergy.

Reading Material:

1. Modi's Medical Jurisprudence and Toxicology-23rd Ed. Publisher-Lexis Nexis Butterworths Wadhwa.
2. Anil Aggrawal, Essentials of forensic medicine and toxicology, Avichal publishing company.
3. Parikh's Textbook of Medical Jurisprudence, Forensic medicine and Toxicology- C.K. Parikh, CBS Publishers and Distributors.
4. Lange's Basic and Clinical Pharmacology, 10th Ed. (2007) by Bertram G. Katzung, McGraw-Hill Publishers, Pg. (934-943).
5. Text book of Micro chemistry of poisons including their physiological, pahalogical and legal relation.-Theodore George Wormley: Internet ref: book.google co.in.
6. A TEXTBOOK OF MODERN TOXICOLOGY by Ernest Hodgson
7. Casarett & Doll Toxicology, The basic Science of Poisons.
8. Clark, E.G.C.; Isolation and Identification of Drugs, Vol. I and Vol. II, Academic Press, (1986).
9. DFS Manual Forensic Toxicology
10. Sunshine I; Year book of Toxicology, CRC Press Series, USA (1989 – 93).
11. Michael J. Deverlanko etal: Hand Book of Toxicology CRC Press, USA (1995).
12. Prakash M. et.al; Methods in Toxicology Anmol Publication, New Delhi (1998).
13. Balraj S. Parmar etal; Pesticide Formulation, CBS Publishers, New Delhi (2004).
14. Reiss C et.al; Advance in Molecular Toxicology, Utrecht, Netherlands (1998).
15. Morgan B.J.T; Statistics in Toxicology, Clarendon Press, Oxford (1996).
16. Jorg Rombke etal; Applied & Ecotoxicology Lewis publishers NY (1995).
17. Shayne C.Gad etal; Acute Toxicology Testing Academic Press California USA (1998).
18. Chadha PV; Hand Book of Forensic Medicine and Toxicology, Jaypee Brothers New Delhi (2004) Semester-II FS-10832.
19. Turner Paul; Recent Advances in Pharmacology & Toxicology, Churchill Livingstone, Elenburgh (1989).
20. Chadha PV; Hand Book of Forensic Medicine and Toxicology, Jaypee Brothers New Delhi (2004) Semester-II FS-10832.

21. Cravey R.H, Baselt, R.C; Introduction to Forensic Toxicology, Biochemical Pub. Davis C A (1981).
22. S. N. Tiwari, Analytical Toxicology, Govt. of India publications, New Delhi 1987.
23. Willard H. H. et. al : Instrumental Methods of Analysis 1974.
24. Moonesens A. A. et. al. : Scientific Evidence in Criminal Cases 1973.
25. Lundquist and Curry: Methods of Forensic Sciences 1963.
26. Arena Poisoning, Chemistry Symptoms and treatment.
27. Analysis of Plant Poisons, Dr. M P Goutam.
28. Drug Abuse Handbook, Karch.s.

M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-IV (Lab Course)

PSFSC P401: Lab Course -7

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Separation and identification of volatile liquid by simple distillation.
2. Analysis of explosion residues (preliminary analysis, GC, GC-MS, ion chromatography {for inorganic explosive})
3. Identification and comparison of explosives by FT-IR technique.
4. Explosive analysis by spot tests and FTIR.
5. Systematic analysis of explosive residues by GC-MS, HPLC
6. Analysis of chemical fertilizers.
7. Forensic analysis of oils and fats.
8. Analyses of hand wash in trap cases by TLC and spectroscopy.
9. Analysis of forensically important cosmetics.
10. Systematic analysis of pharmaceutical products as per IPC specification by using HPLC.
11. Systematic analysis of pharmaceutical products as per IPC specification by using GC.
12. Systematic identification of anti-bacterial and anti-pyretic drug by TLC, UV, HPLC.
13. Extraction and identification of organophosphorus pesticides from biological matrices.
14. Extraction and identification of organochlorous pesticides from biological matrices.
15. Extraction and identification of carbamates pesticides from biological matrices.
16. Determination of phosphine in poisoning cases due to Aluminium phosphide and zinc phosphide in Viscera by chemical and instrumental techniques.
17. Preliminary screening of volatile poisons from biological matrices using color test.
18. Screening of volatile poisons from biological matrices using UV-VIS spectrophotometer with report writing.
19. Analysis of viscera for volatile organic and inorganic poisons.
20. Systematic extraction, and identification and non-volatile drugs and poisons by various techniques.
21. Determination of sodium and potassium from biological materials by flame photometry.
22. Determination of sugar from blood and urine by characteristics chemical tests.
23. Identification of proteins by spot tests.
24. To study the separation of metal ions by paper chromatography.
25. Identification of air-pollutants by raman spectrophotometer.
26. Extraction and identification of strychnine by TLC, HPLC/GC.

27. Extraction and identification of plant poisons from biological matrices.
28. Identification of vegetable poisons by chemical and Instrumental method
29. Extraction and analysis of animal poison.
30. Analysis of viscera for animal poison by TLC
31. Analysis of animal and insect toxins.
32. Analysis of viscera in case of food poisoning by chemical, microscopic and instrumental techniques.

**M. Sc. FORENSIC SCIENCE
(Forensic Chemistry and Toxicology)
SEMESTER-IV (Lab Course)**

PSFSC P402: Project

Hours per week – 08

Credits – 04

Project will be compulsory to all students. Students will carry out project work individually. Concerned department shall provide all required infrastructure to carry out project work. The format for project report will be similar to the research thesis style; incorporating chapters on: Introduction, Review of Literature, Materials and Methods, Results and Discussion and References/Bibliography. The project report will be submitted in a typewritten and bound form. Students will present their work for evaluation. Copy of each project report will be submitted to the respective department. Project work on forensically significant and need based problems in the area of Forensic Chemistry and Toxicology and other forensically important topics as per local, regional, national and international need.

Syllabus for

M. Sc.

Forensic Science

Semesters - III & IV

Specialization - 3:

Forensic Biology, Serology and DNA Finger Printing

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-III (Theory Paper)

PSFSB301: Forensic Anthropology

Hours per week – 04

Credits – 04

Overview –

- This paper deals with Anthropology, Dermatoglyphics, Osteology and Odontology.

Objectives –

- To understand various aspect of anthropology and their use of evidence.
- To understand bone formation, identification of various bone with peculiar characteristics.
- To understand collection and preservation of various human remains; their analysis and evaluate their evidential value.

Outcome – The learner will-

- Know about different bones and tooth.
- Understand their procedure of collection and analysis to estimate evidential value.
- To formulate new research model/techniques for analysis.
- Understand applications of current knowledge of bone and tooth for further research.

Unit I: Basics of Anthropology and Dermatoglyphics

Genesis and Developments in Anthropology. Human Physique: Somatotypes – Ectomorphy, Mesomorphy and Endomorphy. Methods of somatotyping: Sheldon's and Heath-Carter's methods. Principles and methods of anthropometry. Measurements on the living and skeletal parts. Landmarks on human body and measurement techniques. Somatological characteristics of various parts of the human body. Genetic traits of forensic importance.

Dermatoglyphics: Development of dermal ridges in intra-uterine life. Finger, palm and sole prints, palmer lines and creases, plantar creases, human foot morphological variations. Role of anthropology in identification of person.

UNIT –II: Osteology

Osteology of the Human Skeleton. Distinguishing human from non-human bones. Terminology associated with gross morphology of bone, skeletal direction. Skeletal trauma and pathology. Racial differences in skull, mandible, pelvis, long bones and scapula. Studies on stature reconstruction in various population groups. Exhumation- purpose and procedure. Maceration- purpose and procedure. Recovery and packaging of skeletonised and burnt remains.

Pre-natal and post-natal stages of growth and development. Factors affecting growth and

development. Age assessment - decimal age calculation, age grouping. Chronological and developmental age - methods of assessing developmental age, dental age, skeletal age, morphological age and secondary sex character age. Significance of growth studies in forensics. Virtual forensic anthropometry.

UNIT –III: Osteology

Skeletal age (earlier years): Criteria of age in human skeleton – Post natal appearance and union of centers of ossification, pre-natal ossification, differences due to race.

Skeletal age (later years): Suture closure, pelvis, long bones. Osteon counting. Sex typing of skeletal remains: Sexual dimorphism in bone. Sex differences in skull, pelvis and long bone. Accuracy of sex and age determination of adult skeleton remains. Calculation of stature from long bones. Use of immature and fragmentary long bones in stature calculation. Restoration of physiognomic details from skull- relation of the skull to photographs. Restoration of the head from the skull. Use of radiography of skull and other bones in skeletal identification.

UNIT –IV: Forensic Odontology

Forensic Odontology: Definition and scope of forensic odontology, types of dentition, basic structure of human tooth, types of teeth and their morphology, cemental annular rings and determination of age from teeth using various methods (Kvaal's dental age calculations, tooth cementum annulations, aspartic acid racemisation. Schour and Messler method, Gustafson and Koch method), dental anomalies and their role in personal identification. Palate rugoscopy, cheiloscopy, odontometric and facial index. Mandibular canine index, odontometric dimensions and indices in sexual dimorphism.

Bite marks: Types & forensic importance. Collection and preservation of bite mark samples, analysis of Bite marks and presentation of bite mark evidences in court of law. Role of Forensic Odontology in mass disaster victim identification. Difference between human or animal bitemarks. Dental charting. Comparison of Ante-mortem and postmortem dental records. Shape comparative interactive programme (SCIP), dental paint software, Xero-radiography. Software technology in Odontology (Bite mark analysis).

Reading Material:

1. Maria Teresa, Tersigni-Tarrant, Natalie R. Shirley; "Forensic Anthropology: An Introduction", CRC Press, Taylor & Francis Group, 2012.
2. Angi Christensen, N. Passalacqua, & E. Bartelink; "Forensic Anthropology: Current Methods and Practices", Academic Press, Elsevier, 2014.
3. Anil Mahajan & Surinder Nath; "Application areas of Anthropology", Reliance Publishing House, 1992.
4. Goutam Shubra; "Introduction to Forensic Examination", Selective Scientific Books, 2008.
5. Megan Brickley & Roxanna Ferllini; "Forensic Anthropology: Case Studies from Europe", Charles C. Thomas Publisher, Springfield, Illinois, USA, 2007.
6. Indra P. Singh & M.K. Bhasin; "A Manual of Biological Anthropology" Kamla Raj Enterprises, 2004.
7. Fred Plog, Clifford J. Jolly & Danial Bates; "Anthropology", Alfred AKNOPF, New York, 1976.
8. Kroeber; "Anthropology", Oxford & IBH Publishing Co., 1972.
9. Robert Pickering & David Bachman; "The use of Forensic Anthropology" CRC Press, 2009.
10. Nirmal Kumar Bose; "Anthropology", Narayan Press, 1972.
11. B.R.K Shukla & Sudha Rastogi; "Physical Anthropology", Palaka Prakashan, 2005.
12. James Robertson; "Forensic Examination of Hair", Taylor and Francis 1999.
13. Inderbir Singh; "Human Osteology", Jaypee Brothers, 2004.
14. Michael W. Warren, Heather A. Haney & Laurel E. Freas; "The Forensic Anthropology Laboratory", CRC Press, 2008.
15. Fazekas, I Gy; "Forensic in Foetal Osteology", Akademiai Kiado, 1978.
16. "Forensic Recovery of Human Remains", Dupras, T.L. CRC Press.

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-III (Theory Paper)

PSFSB302: Molecular Biology and Immunology

Hours per week – 04

Credits – 04

Overview –

- This paper deals with Basics Molecular Biology, Eukaryotic Genome, Immunology and Serological techniques.

Objectives –

- To understand various aspect of molecular biology, immunology and serological techniques.
- To understand basic and advanced concept of molecular biology, immunology and serological techniques.
- To understand application of molecular biology, immunological or serological techniques.

Outcome – The learner will-

- Know about molecular biology, few concepts of immunology and serological techniques.
- Understand their procedure of serological techniques.
- Understand applications of current knowledge of molecular biology and immunology for further research.
- To formulate new research model/techniques for analysis if possible.

UNIT –I: Molecular Biology

Central dogma of molecular biology, process of DNA replication, properties of DNA polymerases, chromosome replication initiation at ori C & termination at ter C, concept of replicon, replicating linear DNA in eukaryotes, multiple origins of replication eukaryotic chromosomes.

Transcription of genes: terminologies- eukaryotic genome, cistrons, coding sequence & ORF, RNA polymerases types & function, Activators, repressors, regulatory proteins. Transcription in eukaryotes, transcription of r RNA, t RNA & protein encoding genes in eukaryotes, enhancer control of transcription.

Protein Synthesis: Initiation, elongation & termination of protein synthesis, transcription, translation coupled in bacteria, initiation of protein synthesis in eukaryotes, role of molecular chaperon in protein folding, post translation modification,

Regulation of transcription in prokaryotes: Significance of gene regulation, alternative sigma

factor in prokaryotes: Heat shock sigma factors, sigma factor in *Bacillus* spore formation, activators & repressors in positive & negative regulation. Crp protein-global control in protein synthesis. Antitermination. Regulation of transcription in eukaryotes: Enhancers and insulator sequences.

Unit II: Eukaryotic Genome

Eukaryotic Genome: Structure of chromatin, chromosome, centromere, telomere, nucleosome, genome organization, chromatin remodeling; types of histones, histone modifications-methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation, repetitive and non-repetitive DNA sequence, law of DNA constancy, C value paradox and genome size, karyotype and ideogram, chromosome banding pattern.

Chromosomal Basis of Inheritance: Gene linkage. Chromosomal variations/aberrations, non-disjunction of X chromosomes, genotypic sex determination, and genetic sex determination, X – linked recessive inheritance, X-linked Dominant inheritance, Y linked inheritance, and chromosomal disorders associated with crime. Human Genome Project (HGP)- Scope, forensic significance & ethical issues. Heterochromatin, methylation & acetylation in gene expression, gene silencing, X –chromosome inactivation.

Unit III: Antigen-Antibody interactions

Antigen-antibody interactions. Major Histocompatibility Complex structure and functions. B-cell receptor and T-cell receptor, generation of diversity. Complement system. Transplantation, graft vs host reaction, mixed lymphocyte reaction. Cytokines, hypersensitivity, immunity to microbes (protozoa, bacteria, fungi, intracellular parasites, helminthes & viruses). AIDS and other immunodeficiencies. Vaccine: natural, synthetic & genetic, problem and prospect associated with development of vaccine for diseases like AIDS, cancer and malaria. Immunodiagnostics and immunotherapy in virology.

UNIT –IV: Serological Techniques

Immuno technology – Antigen-Antibody interaction: Precipitation and agglutination of the Ag – Ab. Mancini's Radial immune diffusion. Ouchterlony's Double diffusion. Haemagglutination–Agglutination inhibition. Passive agglutination. Immuno electrophoresis. Rocket immune electrophoresis. RIA, ELISA, western blot. Complement fixation test, inhibition of complement fixation. Direct and indirect Coomb's test. Immediate and delayed Hypersensitivity. Abzymes, hybridoma technology and generation of monoclonal and polyclonal antibody.

Reading Material:

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

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-III (Theory Paper)

PSFSB303: Forensic Biology

Hours per week – 04

Credits – 04

Overview –

- This paper deals with Body fluids and their analysis, Hair and Fiber analysis and Population genetics.

Objectives –

- To understand various aspect of body fluids, hair and fiber and population genetics.
- To understand composition and analysis body fluids, constitution of hair and fiber and basic and advanced concept of population genetics.
- To understand various application of body fluids, hair and fiber and population genetics.
- To understand evaluation of evidential value of body fluids, hair, fiber and population genetics.

Outcome – The learner will-

- Know about body fluids, hair and fiber and population genetics.
- Understand their procedure of analysis for, hair ,fiber and utility of population genetics.
- Understand applications of current knowledge of body fluids, hair, fiber and population genetics for further research.
- To formulate new research model/techniques for analysis if possible.

Unit I: Body Fluid

Types and distribution of body fluids, urine formation, composition, properties, abnormal constituents and clinical significance, Beta HCG; CSF, lymph, amniotic fluid, sweat, composition, formation and function. Blood, semen, synovial fluid, gastrointestinal secretions: composition, formation and function. Tears, milk, faeces. Saliva, aqueous humour, vaginal fluid, epithelial cells and their analysis and forensic significance.

Unit II :Body Fluid Examination

Blood and blood stains– Physical examination, presumptive test (TMB, Kastle-Meyer Test, Luminol), confirmatory tests (Takayama, Teichmann, spectrophotometric).Examination of Menstrual blood & its stains-Physical & Microscopic examination, Identification by Fibrin Degradation product. Identification of other body fluids and their stains. Semen and seminal stains-Physical Examination, Presumptive test (Acid Phosphatase Test), Confirmatory test(microscopic examination)Gram staining, cross-over electrophoresis. Examination of vaginal

fluid & stains of vaginal secretions-Physical examination, SAP/VAP electrophoresis, Lugol's stain. Examination of saliva & saliva stains-starMFS-iodine test,salivary haemagglutinin test ,radial diffusion test for amylase. Examination of vomit-test for mucus,test for free HCl(Gunzberg's test),endothelial cells .Examination of urine stains-Physical stains, odour test ,urea nitrate crystal test, creatinine test. Current research in body fluid analysis.

Unit III: Hair & Fiber Examination

Sampling, hair examination-temporary mount, scale casting, nail polish /cellulose acetate method, permanent mount, cross-sectioning, micrometry, sex determination from hair root sheath. General characteristics of human hair, morphological characteristics of hair for racial determination. Characteristics of hair from different sites. Animal and human hair-general differences. Fibre examination-microscopic, temporary mount, Maceration of plant fibres, cross-sectioning, physical methods (twist on drying, floatation method, burning test). Cotton, Akmund, coir, wool, silk, jute, sisal, abaca rayon silk, wool, asbestos, nylon. Fabrics & cordage- sample handling, analysis, fabric examination, cordage examination

Unit IV: Population genetics

Gene frequencies, bi-allelic system, Hardy- Weinberg equilibrium, measurement of frequency distribution, closeness of fit with HWE, combined frequency of occurrence, probability of match and discrimination, discrimination power, power of exclusion, evidence evaluation, errors in interpretation. Paternity index, likelihood of paternity. Simple case genotypic frequencies, Simple case allelic frequencies, Matching of DNA profiles, ANOVA analysis and related cases studies of Indian origin. Statistics based problems.

Reading Material:

1. Blood biochemistry : Nicholas J Russell
2. Human blood groups-Chemical and biochemical basis of antigen specificity (Second edition):
3. Helmut Schenkel –Brunner, Springer Wein New York
4. Blood: Principles and practice of hematology (2003): Robert L Handin, Samuel Lux, Thomas Stossel.
5. Medical laboratory techniques: Godkar and Godkar
6. Blood group typing: Danford and bowly.
7. Blood grouping on man: R.R. Race and Sanger.
8. Blood grouping techniques: Boorman, Dodd. B, Lincoln. PB

9. Typing of blood stains: Callifird, Bryan
10. Physical Anthropology, B.R.K. Shukla & Sudha Rastogi Palaka Prakashan,
11. Forensic examination of hair, Robertson, James Taylor & Francis, (1999)

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-III (Theory Paper)

PSFSB304: Instrumentation in Forensic Biology

Hours per week – 04

Credits – 04

Overview –

- This paper deals with various aspects of instruments utilized in forensic biology laboratory.

Objectives –

- To understand various aspect such as principle, working and application.

Outcome – The learner will-

- Know about principle, working and application.
- Understand their utility of instruments in analysis of various body fluid, others biological evidence and other evidence .

Unit I: Electrophoresis and Chromatographic Techniques

Basic component of electrophoresis, types of electrophoresis, General principles, Working, uses and Forensic Applications of PAGE, Isoelectric focusing and capillary electrophoresis, Paper chromatography, column chromatography, Thin Layer Chromatography, Adsorption chromatography, Partition chromatography, Gas chromatography, Gas- liquid chromatography, Ion-exchange chromatography, Exclusion (permeation) chromatography, Affinity chromatography, HPLC, HPTLC, Capillary Chromatography.

Unit II: Spectrophotometry

Ultra violet and visible spectrophotometry: Types of sources and stability, wavelength selection, filters-cells and sampling devices, detectors, resolution, qualitative and quantitative methods for detection, Fluorescence and phosphorescence spectrophotometry, Atomic absorption spectrometry, Atomic emission spectrometer, X-ray spectroscopy, Infrared spectrophotometry, Mass spectrophotometer. Working, Principle, Advantage, Disadvantages and Forensic Applications.

Unit III: Other Instrumental Techniques

Nuclear Magnetic Resonance, Maldi-ToF, X-Ray Diffraction, Neutron Activation Analysis, ESDA, Video Spectral Comparator, Next Gene Sequencing, micro-dissection technique, CT, MRI and Laser microdessection, Working, Principle, Advantage, Disadvantages and Forensic Applications

Unit IV: Forensic biological Protocol Development

Identification and Detection of Biomolecules (Carbohydrates, Protein, Lipid, Nucleic acid and other), Separation and Isolation of Biomolecules using basic and advanced technology. Development of platform (Serological, Proteomic and genomic) for detection and identification of various biomolecules. Plant and animal tissue culture techniques.

Reading Material:

1. Biophysical chemistry Principles and techniques: Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath.
2. Instrumental Methods of Analysis 6th Edition. (1986): H.H. Willard, L.L. Merritt Jr. And others. CBS Publishers and Distributors.
3. Instrumental Methods of Chemical Analysis. (1989): Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.
4. A Biologists Guide to Principles and Techniques of Practical Biochemistry. (1975): Williams, B.L. and Wilson, K.
5. Spectroscopy. (Vol. 1): Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
6. Gel Electrophoresis of Proteins- A Practical Approach: Hanes.
7. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
8. Analytical Biochemistry: Holme.
9. Introduction to High Performance Liquid Chromatography: R. J. Hamilton and P. A. Sewell.
10. Spectroscopy: B.P. Straughan and S. Walker.
11. Practical aspects of Gas Chromatography and Mass Spectrometry (1984) by Gordon M. Message, John Wiley and Sons, New York.
12. Gel Chromatography by Tibor Kremmery.
13. Principles and Techniques of Biochemistry and Molecular Biology: Edt. Keith Wilson, John Walker

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-III (Lab Course)

PSFSB P301: Lab Course -5

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Determination of species, sex, origin from hair and preparation of case study.
2. Macroscopic and Microscopic characterization of human hair and animal hair (minimum five animals).
4. Preliminary examination of biological fluids (blood, semen, saliva, sweat, tear and milk).
5. Extraction and isolation, estimation of DNA from buccal swabs, blood (fresh and dried), semen (from various surfaces).
6. Chromosome isolation from various forensic samples.
8. Chromosome staining using various staining techniques.
9. Determination of likelihood ratio using population genetics.
10. Estimation of antibody concentration in body fluid using ELISA technique.
11. Determination of Genetic Concordance, Evaluation of results, frequency estimates.
12. Microscopic study of normal/abnormal RBCs.
13. Microscopic study of semen/sperms.
14. Determination of the paternity index of given data.
15. Determination of combined frequency of occurrence in humans and wildlife.
16. Determination of discrimination power and power of exclusion using wildlife DNA data.
17. Determination of paternity index using serum profile (serum specific markers).
18. Determination of correlation using given data
19. Practical based on Post-mortem Examination in Mortuary

(Note: All practical's require Indian based case study or abstract of review of literature of recent papers)

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-III (Lab Course)

PSFSB P302: Lab Course -6

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Side and site determination from long bones.
2. Stature estimation from various bones (except long bone)
3. Sex determination from various bones (except skull and pelvic girdle).
4. Age determination from different bones.
5. Age estimation from teeth using various methods (including recent advancement).
6. Stature estimation using long bone with various formulations and testing hypothesis.
7. Bite mark analysis using various medico-legal aspects.
8. Isolation of microorganism from soil sample and extraction of nuclear DNA and plasmid DNA.
9. Preparation and transformation of competent E. Coli using calcium chloride
10. Perform a silver staining and fluorescence staining for the detection of DNA/protein
11. Isolation of antigen and determination of its concentration from various body fluids
12. Examination of blood stains: physical and chemical tests; spectroscopic examination
13. Examination of menstrual blood by microscopic, spectroscopic, electrophoretic methods.
14. ABO blood grouping from other body fluids.
15. Synthesis of antibody using various models.
16. Principle and working of various advanced microscopy techniques.
17. RNA profiling in various body fluid for human identification.
18. Determination of electrophoretic profile of body fluid.
19. Chromatographic analysis of body fluid.

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-IV (Theory Paper)

PSFSB401: Advanced DNA Fingerprinting

Hours per week – 04

Credits – 04

Overview –

- This paper deals with Advanced DNA Fingerprinting technology

Objectives –

- To understand various aspect of Advanced DNA Fingerprint, Evidence Evaluation and their application.
- To understand basic and advanced concept of DNA fingerprinting, DNA profiling, Application and interpretation.
- To understand various application of DNA fingerprinting.
- To understand evaluation of evidential value of DNA and related issue.

Outcome – The learner will-

- Know about DNA fingerprinting.
- Understand their procedure of analysis of DNA and utility of fingerprinting technique.
- Understand applications of current knowledge of DNA fingerprinting for further research.
- To formulate new research model/techniques for analysis if possible.

Unit I: DNA Fingerprinting

Possible sources for DNA, collection, transportation and preservation of various forensic samples for DNA profiling. DNA extraction techniques for different forensic samples (early techniques, solid phase extraction, differential extraction, chelex extraction, automated techniques, commercial extraction kits), RNA extraction from different forensic samples.

Determining quality and Quantity of DNA and RNA, Gel elution technique.

DNA Amplification: Types of PCR: Nested PCR, Touchdown PCR, Gradient PCR, Hot-starts PCR, Quantitative PCR, multiplex PCR. DNA quantification by Slot- blot assay, Pico-green micro-titer plate assay, AluQuant human DNA quantification system, endpoint PCR, PCR inhibitors & solutions, Contamination Issues,

Unit II: Advanced techniques in DNA profiling

Uni-parentally inherited genetic markers in ethnic and geographical origin detection, DNA Profiling Kits (Easy DNA, Pro-filer, etc.) DNA fingerprinting of degraded samples, Slot-blot

assay for quantification of DNA, DNA-DNA Hybridization, next generation sequencing, Nano-particle technology in PCR, Drug-DNA interactions, SNP microarray for supplementary paternity testing. Genetic analysis of chromosome X (pentaplex/heptaplex PCR assay), multicopy Y-STR analysis, mitochondrial DNA analysis, DNA multi-reverse parental analysis, cytochrome b analysis, eDNA Personal Effects and DNA analysis (sources and problems), Kinship testing, Lineage marker, Non-human DNA typing., RNA typing.

Unit III: DNA Fingerprinting Applications

Case studies in disputed paternity cases, child swapping, missing person's identity, civil immigration, veterinary, wild life and agriculture cases. Legal perspectives – legal standards for admissibility of DNA profiling, procedural & ethical concerns, status of development of DNA profiling in India & abroad; Limitations of DNA profiling; Population databases of DNA markers –STRs, Mini STRs, SNPs. Uses of STR Typing. New & future technologies: microarrays technology, synthetic DNA, analysis of degraded DNA, low copy number DNA.

Unit IV: Forensic DNA evidence interpretation

Interpretation of DNA typing results: Complicating Factors (Multiple contributors, degradation, and extraneous substances). System specific Interpretational Issues (RFLP, PCR systems).

Assessing strength of evidence: Determination of genetic concordance, evaluation of results, frequency estimate calculations, population substructure, likelihood ratios, and uniqueness of DNA Profile. Analysis of short tandem repeats, assessment of STR profiles, statistical interpretation of STR profiles.

Admissibility standards: Frye, Daubert, and the Federal Rules of Evidence, Landmark cases, The State of Debate. Prosecutor's fallacy, defendant's fallacy. Ethics of DNA analysis and Post conviction DNA analysis.

Reading Material:

1. An Introduction to Forensic DNA Analysis, Rudin, Norah CRC Leviw Publishers, (2002)
2. An Introduction to Forensic DNA Analysis, Inman, Keith CRC Press, (1997)
3. Ancient DNA, Herrmann, Bernd Springer Publishing Co., (1994)
4. . Basics of DNA and Evidentiary Issues, Vij, Krishan Jaypee Brothers, (2004)
5. DNA, forensic and legal applications Kobilnsky, Lawrence John Wiley & Sons, (2005)
6. DNA Cloning 4: Mammalian systems, Glover, D.M.; IRL Press,(1995)
7. DNA Damage and repair, Nickoloff, Jac A Humana Press,(1998)

8. DNA Evidence and Forensic Science, Newton, David E. Viva books private limited, (2010)
9. DNA fingerprinting, Kirby, Lorne W H Freeman and Co, (1992)
10. DNA Fingerprinting: Approaches and applications. T. Burke, Terry Birkhauser Verlage,(1991)
11. DNA in forensic science, Robertson, J Ellis Horwood Ltd., (1990)
12. DNA profiling Eastal, Simon, Harwood academic Publishers,(1993)
13. DNA profiling and DNA fingerprinting, Epplen, Jorg T Birkhauser Verlage,(1999)
14. DNA technology, Alcamo, I Edward Harcourt Academic Press,(1999)
15. DNA tests in Criminal Investigation Trial & Paternity Disputes Singh, Yashpal, Alia Law Agency,(2006)
16. Forensic DNA typing, J.M. Butler Elsevier Academic press,(2005)
17. Forensic DNA technology, Mark A. Farley & James J. Harrington CRC Press,(1991)
18. Forensic DNA analysis, J. Thomas McClintock Lewis Publications, (2008)
19. Forensic DNA typing protocol: Carracedo
20. Rudin N. and Inman K, Introduction to Forensic DNA Analysis, page 97-131, 139-150, 183-195.
21. Progress in Forensic Genetics 10, Proceedings of the 20th International ISFG Congress held in Arachon, France, September 2003.
22. Forensic Science -2008, Embar-Seddon, A and Pass A (Ed),Volumes 1-3(page 424,754, 832).
23. An Introduction to Forensic Genetics,2017, William Goodwin and others, Wiley and Balckwell

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-IV (Theory Paper)

PSFSB402: Microbial Forensics

Hours per week – 04

Credits – 04

Overview –

- This paper deals with micro-organism of forensic interest, environmental aspects, biological agents and their utility in warfare and basic and application of bioinformatics

Objectives –

- To understand various aspect of forensically important microorganism, environmental forensics, biological agents of warfare and bioinformatics.
- To understand basic and advanced concept of mirco-organism, collection and preservation of micro-organism & Bioinformatics.
- To understand various application and interpretation of Bioinformatics.
- To understand evaluation of evidential value of forensically important micro-organism and .bioinformatics.

Outcome – The learner will-

- Know about forensically important micro-organism, environment and bioinformatics.
- Understand their procedure of analysis of micro-organism, environment and bioinformatics.
- Understand applications of current knowledge of micro-organism, environment and bioinformatics for further research.
- To formulate new research model/techniques for analysis if possible.

UNIT I: Microbial and Environmental Techniques

Defining the microbial forensics program, epidemiology, Microbial forensic tools. Dynamics of disease transmission, Outbreak Investigation. Deliberate introduction of a biological agent. Emerging Microbial Forensic Techniques- PCR, Terminal Restriction Fragment Length Polymorphism (TRFLP), Amplified Fragment Length Polymorphism (AFLP), Single Stranded Conformation Polymorphism Analysis (SSCP), Thermal and Denaturing Gradient Gel Electrophoresis (TGGE, DGGE), Amplified Ribosomal DNA Restriction Analysis (ARDRA), Randomly Amplified Polymorphic DNA (RAPD). Non-PCR DNA Fingerprinting techniques with applicability in forensic studies.

Unit II: Microbes of Forensic Importance

Epidemiology of *Bacillus anthracis*, *Yersinia pestis*, *Francisella tularensis*, *Brucella spp.*, *Burkholderia Pseudomallei*, *Clostridium botulinum*, *Listeria monocytogenes* and their

morphological & biochemical studies. DNA of microbes in soil for crime detection.

Fungi of forensic importance: Opportunistic mycoses, *Chytridiomycota zygomycota*, *Aspergillus fumigates*, *Microsporidium*, *Pneumocytosis jiroveci*, *Asp.flavus* & *Candida* sp.. Antifungal agents.

Food borne– shigella, salmonella. Forensic aspects of biological toxins. Microbial forensic analysis of trace and unculturable specimens.

Unit III: Biological agents in warfare

Biological agents in warfare: Collection, transportation and preservation of microbial forensic samples, categories of biological weapons, study of potential bacteria, fungi, viruses, and their toxins, mode of action, identification, preventive measures during handling, laboratory setup, epidemiologic investigation for public health, investigation of suspicious disease outbreak. Bio safety and bio security, bio surveillance, documentation, and case studies.

Toxin analysis using mass spectrometry, Non-DNA methods for biological signatures, Electron beam based methods for bio-forensic investigations, proteomics development and application for bio-forensics, design of genomics, design of nucleic acid signature for pathogen identification and characterization.

Unit IV: Bioinformatics and its Applications

Public domain databases for nucleic acid and protein sequences (EMBL, Gene Bank), database for protein structure (PDB), Bioinformatics methods for microbial detection and forensic diagnostic design: Whole genome analysis, DNA analyses for repeats (Direct and inverted); palindromes, open reading frames, annotations of genes, identification of gene.

Overview of comparative genomics, Computational methods, homology algorithms (BLAST, FASTA) for proteins and nucleic acids, Oligonucleotide probe synthesis, artificial gene synthesis, primer and probe designing (PCR, STR, SNPs of Mitochondrial and genomic DNA) , Preparation of genomic library, Submission of sequence in library, evaluation of primer and probe compatibility. CODIS and NDIS, phylogenetic analysis using various methods.

Reading Material:

1. Microbial Forensics : Bruce Budowle, Steven E Schutzer, Roger G Breeze, Paul S Keim, Stephen A Morse
2. Chemical and Physical Signatures for Microbial Forensics: Cliff, J.B, Kreuzer, H.W, Ehrhardt C.J, Wunschel, D.S

3. Microbial Forensics : Roger G Breeze, Bruce Budowle, Steven E Schutzer
4. Handbook of computational molecular biology: Edt by SrinivasAluru
5. S.C. Rastogi, N. Mendiratta & P. Rastogi; Bio-informatics- Methods & Applications, PHI learning pvt. Ltd., (2009)
6. Dr. Westhead, J.H. Parish & R.M. Twyman, Bio-informatics, Viva Books Pvt Ltd., (2003)
7. Introduction to bioinformatics : Lesk
8. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
9. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
10. Bioinformatic methods and protocols: Misener.
11. Introduction to Bioinformatics by Altwood.
12. Bioinformatics sequence and genome analysis 2nd ed.: David Mount.

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-IV (Theory Paper)

PSFSB403: Ecosystem Management and Wildlife

Hours per week – 04

Credits – 04

Overview –

- This paper deals with Various aspect of Ecosystem, Forensic botany ,Forensic entomology and wildlife.

Objectives –

- To understand various aspect of wildlife, forensic botany and forensic entomology.
- To understand basic and advanced concept of botany, entomology, wildlife and ecosystem and collection and preservation of various samples of botany, entomology and wildlie .
- To understand various application and interpretation of forensic botany, entomology and wildlife.
- To understand evaluation of evidential value of forensically botany, entomology and wildlife.

Outcome – The learner will-

- Know about forensic botany, forensic entomology and wildlife.
- Understand their procedure of analysis of botany, entomology and wildlife.
- Understand applications of current knowledge of botany, entomology and wildlife for further research.
- To formulate new research model/techniques for analysis if possible.

Unit I: Wildlife Forensic

Protected and endangered species of animals and plants; sanctuaries and their importance; relevant provision of wild life and environmental act; types of wildlife crimes, different methods of killing and poaching of wildlife animals; enforcement of wildlife protection policy, wild animals as pharmacopeias, wildlife artifacts (bones, skin, fur, hair, nails, blood, feather, etc.), trade in wild animals, elephant-, indian rhino, wild cat, poisonous snakes for venom and skin, crocodiles, salamanders, deer, birds (feathers Macau parakeets, whales, sharks, spectacle bear, Himalayan antelopes.

Recovering evidence at poaching scenes, locating the burial: anomalies on the surface international trade in reptile skins, challenges to species identification of reptile skin products, species and products represented in the reptile skin trade, reptile scale morphology basics and current limitations, identifying features of major reptile groups. wild DNA testing, wildlife DNA

barcoding, Wildlife (Protection) Act-1972. Reconstruction of wildlife crime scene.

UnitII: Environment and Ecosystems

Ecosystem characteristics structure and function; environmental pollution , xenobiotic and recalcitrance, Introduction to BOD and COD, use of biosensors to determine the quality of environment, Introduction and scope of environmental management, basic concepts of sustainable development, Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS), international organization for standardization (ISO), ISO 14000 standards and certification, environmental safety, risk management and emergency preparedness, international summit and treaties, important dates dedicated to environmental management

Unit III: Forensic Botany

Identification and matching of various types of wood, timber varieties, seeds and leaves. Types of vegetable fibers and methods of their identification. Planktons and diatoms- forensic importance. Isolation of diatom from water, body organs and tissues. Identification of pollen grains and starch grains. Paper pulp examination.

Identification of poisonous plants of forensic significance: *Abrusprecatorius*, *Aconitum*, *Argemone Mexicana*, *Cannabis sativa*, *Atropa belladonna*, *Erythroxylum coco*, *Lathyrussativus*, *Manihotutilissima*, *Neriumindicum*, *Ricinuscommunis*, *Strychnosnuxvomica*, Ergot, Opium, Dhatura and Psilocybin mushrooms.

Unit IV: Forensic Entomology

History, significance, determination of time since death-Dipterans larval development- life cycle of blowfly, housefly, flesh-fly.

Successional colonization of body, determining whether the body has been moved, body disturbance, presence and position wounds, linking suspect to the scene, identification of drugs and toxins from the insects and larvae feeding on the body, entomology as an evidentiary tool in child and senior abuse cases and animal abuse cases, collection, rearing and preservation of entomological evidence.

Reading Material:

1. Concept in wildlife Management, Hosetti, B.B Daya publishing 103House
2. Forensic science in wild life investigation, Lincee, Adrian CRC Press, Taylor & Francis
3. The wild life (protection) act, Baalu, T.R.1972, Nataraj Publication
4. Wild life (Protection act, 1972), Universal Publication
5. Wildlife protection act, 1972; Natraj Publishers
6. Timber Identification, N. Clifford; Leonard Hill Ltd.,
7. A manual of wood identification, Herbert L. Edlin Viking Press,
8. Man-made fibres, R.W. Moncrieff Newness butter worth
9. Identification of vegetable fibres., Dorothy catling & John Grayson Chapman & hall ltd
10. Pollen morphology & Plant taxonomy: angiosperms (an introduction to palynology),
11. Erdtman, G Hafner Publishing Co.,
12. Forensic botany, Coyle, Heather Miller CRC Press,
13. College botany, Gangulee, Hirendra Chandra New Central Book Agency,
14. Plant anatomy, Esau, Katherine Wiley Eastern Ltd,
15. Plant anatomy, Chandurkar, P J Oxford & IBH Publishing Co,
16. Systematic botany for degree students, Singh, Jagjit S Chand & Co.,
17. The poisonous plants, H.C. Long Asiatic Publishing House,
18. Plant Anatomy, B.P. Pandey S. Chand& Co., New Delhi, (1998)
19. Environmental Law- The Law & policy relating to protection of environment, Ball Simon Universal Law Pub Co, Delhi,
20. Environmental Forensic Principles and Applications, Morrison Robert D, CRC Press,
21. Forensic Entomology: Jason H Byrd & James L Castner
22. Insect Biology : Hovard Evan
23. Fundamentals of Entomology, Richard J. Flzinga Prentice hall of India pvt ltd, (1978)
24. Entomology & death- A procedural guide, Catts E.P & Haskell NH; Joyce's print shop (1990)
25. A manual of Forensic Entomology Smith DGV; Ithaca NY Camstock Univ. Press, USA (1986)
26. General text book of Entomology, O.W. Richards & R.G. Davis; Chapman & hall ltd, (1973)

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-IV (Theory Paper)

PSFSB404: Forensic Pathology and Quality Management

Hours per week – 04

Credits – 04

Overview –

- This paper deals with Forensic Pathology, Forensic Histopathology and Quality Management

Objectives –

- To understand various aspect of Forensic Pathology, Histopathology and Quality management.
- To understand basic and advanced concept of forensic pathology, forensic histology and quality management
- To understand various application and interpretation of forensic histopathology, forensic pathology and quality management..
- To understand evaluation of evidential value of forensic pathology, histopathology and quality management

Outcome – The learner will

- Know about forensic pathology. Histopathology and quality management.
- Understand their procedure of analysis of histopathology.
- Understand applications of current knowledge of forensic pathology, forensic histopathology for further research.
- To formulate new research model/techniques for analysis if possible.

Unit I: Basics of Forensic Pathology

Introduction to medico legal case work, identification and collection of physical evidence, Identification of remains, natural death. sexually related homicide, muscular physiology , causes of death – asphyxia, drowning, time of death- decomposition of human remains and whole body. Post Mortem Examination including wounds, injuries, Digestive System & digestive paths of macromolecules, enzymes & end products Undigested stomach contents post mortem, Ethical aspect of post mortem, Role of a Forensic Pathologist.

Unit II : Forensic Taphonomy

Introduction of taphonomy, fluvial taphonomy.

Collection of macroscopic osseous taphonomic data and the recognition of taphonomic suites of characteristics, bone density and bone attrition, microscopic destruction of bone, effects of burial environment on osseous remains, marine environmental alterations to bone, contemporary

cultural alterations to bone, marine environmental alterations to bone(marine, terrestrial, subaerial and thermal), avian taphonomy, taphonomic bone staining and changes , DNA survivability in skeletal remains, effects of recovery methods.

Unit –III: Forensic Histopathology

Introduction to forensic histopathology, fixation of tissues, processing of tissue in histopathology laboratory, decalcification of bony and hard tissue for histopathology processing, embedding of tissue in histopathology, tissue microtomy: principle and procedure, frozen section-principle and procedure, staining principle and general procedure of staining of the tissue.

Haematoxylin and eosin stain of the tissue section, special stains for the carbohydrate, protein, lipid, nucleic acid and pigments. immunocytochemistry in histology and cytology, digital image analysis and virtual microscopy in pathology.

UNIT –IV: Quality Assurance in Forensic Biology

Ethics in laboratory (introduction, why unethical acts occur, ethical decision-making teaching ethics to forensic scientists' ethical dilemmas, ethical dilemmas facing crime laboratory directors and prevention), introduction to accreditation. international programs, certification, personal competence, proficiency tests, standards.

Strategic management (introduction, importance of strategic planning, mission statements, developing a strategic plan, obstacles to achieving consensus, a scenario, organizational management programs, organizational excellence.

Safety in the forensic laboratory: Introduction, safety culture, contents physical hazards, electrical hazards, compressed gases and compressed gas cylinders, chemical hazards, chemical management, biological hazards, facility safety equipment, personal protective equipment.

Reading Material:

1. Forensic Pathology- Dominic J. Di Mario, Elsevier Publishing Company (1989)
2. Forensic Pathology for Police, Death Investigators, Attorneys, and Forensic Scientists, Joseph Prahlow, Humana Press, (2010)
3. Forensic Pathology Principle and Practice David Dolinak, Evan Matshes, Emma O. Lew. Academic Press(2005)
4. Handbook of Forensic Pathology , Vincent J. M. Di Maio, Suzanna E. Dana Landes Bioscience (2012)
5. Handbook of Forensic Pathology , Vincent J. M. Di Maio, Suzanna E. Dana Landes Bioscience (2012)

6. Knight's Forensic Pathology. Pekka Saukko, Bernard Knight, CRC Publisher (2015)
7. Forensic recovery of human remains: Dopras, Schultz, Whirler, Williams
8. Advances in Forensic Taphonomy, Method theory and Archaeological perspective
9. Forensic Typonomy: The Postmortem Fate of Human remains, William D Haglund; Marcella H Sorg, CRC Press publisher (1997)
10. The laboratory Quality Assurance system: A manual of Quality Procedures and forms. Thomas
11. A Ratliff. 2003 3rd ed. John Wiley & Sons ISBN. 0-471 26918-2 Systematic Quality
12. Management Gary B Clark. 1995 Practical Laboratory Management Series.
13. Quality assessment of chemical Measurements John K. Taylor. CRC Press 1987. 087371-097-5.
14. Quality in the analytical chemistry laboratory E. Prichard. 1995 JohnWiley ISBN 0471955418
15. IS/ISO/IEC 17025 : 2005 General Requirements for the competence of testing and calibration laboratories
16. Juran's Quality Control Handbook, Fourth Edition, J.M. Juran, Frank M. Gryna, McGraw- Hill
17. International Editions, Industrial Engineering Series (1988)
18. Total Quality Control Essentials - Key Elements Methodologies and Managing for Success,
19. Quality Control & Application, Bertrand L. Hansen, Prabhakar M. Ghare, Prentice-Hall of India Pvt. Ltd., New Delhi-110001 (1993)
20. Basic and Advanced Laboratory Techniques in Histopathology and Cytology, Pranab Dey, Springerlink.

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-IV (Lab Course)

PSFSB P401: Lab Course -7

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Reconstruction of wildlife crime scene.
2. Recognition, Collection and preservation of various forensically important evidence.
3. Extraction of mitochondrial DNA from forensic samples.
4. Culturing forensically important microorganism.
5. Extraction and isolation, estimation of DNA from buccal swabs, blood, semen and other biological samples (Case report and Forensic science laboratory formats).
6. Identification and individualization of blood samples (Testing a hypothesis).
7. Study of injuries and wounds in wildlife and humans.
8. Identification of pollen grains of forensic significance.
9. Extraction/Isolation/Identification of diatoms.
10. Isolation of entomological evidence from various samples (Water, decomposed body of animals).
11. Detection of DNA/protein using silver staining and fluorescence staining.
12. Study of STR in wildlife and human (till matching of profiles).
13. Evaluation of compatibility and submission of gene sequence.
14. Hair analysis of various wild animals and preparation of digital library.
15. Study of various diseases in wild animal and humans.
16. Study of various zoonotic infections.
17. DNA typing technique for wildlife (RFLP, PCR, etc.).
18. Identification of wild type animals using DNA bar-coding technique.
19. Writing of Forensic Report on various evidences
20. Practical based on Hypothesis testing
 - A. t-tests
 - B. chi square tests
 - C. Regression analysis

21. Practical based on parametric tests

22. Practical based on Probability

23. Practical based on wildlife crime scene or zoological garden.

M. Sc. FORENSIC SCIENCE
(Forensic Biology, Serology and DNA Finger Printing)
SEMESTER-IV (Lab Course)

PSFSB P402: Project

Hours per week – 08

Credits – 04

Project will be compulsory to all students. Students will carry out project work individually. Concerned department shall provide all required infrastructure to carry out project work. The format for project report will be similar to the research thesis style; incorporating chapters on: Introduction, Review of Literature, Materials and Methods, Results and Discussion and References / Bibliography. The Project report will be submitted in a typewritten and bound form. Students will present their work for evaluation. Copy of each project report will be submitted to the respective department. Project work will be majorly based on research in forensically significant and need-based problems in the area(s) of Forensic Biology, Serology, Anthropology, Entomology, Wildlife, Environment and other forensically important topics as per local, regional, national and international need.

Syllabus for
M. Sc.
Forensic Science
Semesters - III & IV

Specialization- 4:

Digital and Cyber Forensics and IT Security

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - III (Theory Paper)

PSFSD301: Network Forensics

Hours per week – 04

Credits – 04

<p>Unit I : Practical Investigation Strategies Real world cases, Foot prints, Concept of digital evidence, challenges relating to network evidence, Network Forensic Investigation Methodology. Technical Fundamentals Sources of Network Evidence, Principals of Internetworking, IP Suite.</p>
<p>Unit II : Evidence Acquisition Physical Interception, Traffic Acquisition Software, Active Acquisition. Traffic Analysis Protocol Analysis, Packet analysis, Flow Analysis, higher level traffic analysis.</p>
<p>Unit III : Statistical Flow Analysis Process overview, Sensors, Flow record export Protocols, Collection and Aggregations, Analysis Wireless Network Forensics IEEE Layer 2 protocol series, WAPs, Wireless traffic capture and analysis, Common attacks, Locating wireless devices</p>
<p>Unit IV : Network Intrusion Detection System(NIDS) and Network Intrusion Prevention System(NIPS) Investigate NIDS/NIPS, Typical NIDS/NIPS Functionality, Modes of Detection, Types of NIDS/NIPS, NIDS/NIPS Evidence acquisition, Comprehensive Packet Logging, SNORT</p>

Reading Material:

1. Network Forensics: Tracking Hackers through Cyberspace, 2012
2. Learning Network Forensics by Samir Datt
3. Network Forensics by Ric Messier
4. Fundamentals of Network Forensics: A Research Perspective (Computer Communications and Networks) by R.C. Joshi and Emmanuel S. Pilli
5. Ethical Hacking and Penetration Testing Guide - Baloch, Rafay
6. The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy by Patrick Engebretson
7. Mastering Kali Linux for Advanced Penetration Testing - by Vijay Kumar Velu

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - III (Theory Paper)

PSFSD302: Mobile Application Development

Hours per week – 04

Credits – 04

Unit I :

Introduction Object Oriented Programming and Java

Features of JAVA, Data types, variable, expressions, operators and control structures, arrays, string, File handling, Object oriented programming concepts, Classes and Objects, Constructors, Method overloading, Access specifies, Abstract classes, Inheritance, Runtime polymorphism, Method overriding, using Package and Interface, Collections, Exception Handling, Event handling Mechanism.

Unit II :

Mobile App or Website , Mobile user interface design, Android Programming

Mobile Web Presence, Mobile Applications, Marketing, App as a Mobile Web App, Effective Use of Screen Real Estate, Understanding Mobile Application Users, Understanding Mobile Information Design, Understanding Mobile Platforms, Using the Tools of Mobile Interface Design. What is android, obtaining the required tools, First Android Application, Anatomy of an Android Application

Unit III :

Activities, Intents and Android User Interface

Understanding Activities, Linking Activities using Intents, Calling Built- In Applications using Intents, Displaying Notifications, Understanding the Components of a Screen, Adapting to Display Orientation, Managing Changes to Screen Orientation, Utilizing the Action Bar, Listening for UI Notifications

Designing User Interface with Views, Displaying Pictures and Menus with Views, Data Persistence

Basic Views, Picker Views, List Views, Using Menus with Views, Some Additional Views, Saving and Loading User Preferences, Persisting Data to Files, Creating and Using Databases

Unit IV :

Messaging , Location Based Services and Networking

SMS Messaging, Sending e-mail, Displaying Maps, Getting Location Data, Monitoring a Location, Consuming Web Services Using HTTP

Developing Android Services

Creating Your Own Services, Establishing Communication between a Service and an Activity, Binding Activities to Services, Understanding Threading.

Reading Material:

1. The complete reference JAVA2, Herbert schildt. Tata McGraw Hill
2. Core Java for beginners, Sharanam Shah and vaishali shah, SPD
3. Programming with Java A Primer, E.Balaguruswamy Tata McGraw Hill
4. Jeff McWherter, Scott Gowell, "Professional Mobile Application Development", Wiley & Sons Inc., 1st edition, 2012
5. Wei-Meng Lee, John, "Beginning Android™ 4 Application Development", Wiley & Sons Inc., 1st edition, 2012.
6. Paul Deital and Harvey Deital, "Android How to Program," DetialAssociates Publishers, 1st edition, 2013.
7. Zigurd Mednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura, "Programming Android Java Programming for the New Generation of Mobile Devices", O'Reilly Media, 1st Edition, 2011.
8. Satish Bommisetty, Rohit Tamma and Heather Mahalik, "Practical Mobile Forensics – Dive into mobile Forensics on iOS, Android, Windows and Blackberry Devices with action-packed, practical guide", PACKT Publishing, 2015

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - III (Theory Paper)

PSFSD303: Digital Electronics, Microprocessor and IoT

Hours per week – 04

Credits – 04

Unit I :

Digital Electronics

Introduction to Number Systems -Types-Decimal, Binary, Octal, Hexadecimal, Conversion from one number system to other; Binary arithmetic operations; Representation of Negative Numbers;1's complement and 2's complement, Complement arithmetic, BCD code, ASCII code, EBCDIC code. Logic Gates- Basic Gates, Other gates, Universal Gates and realization of other gates using universal gates.

Rules and laws of Boolean algebra, Demorgan's Theorems, Boolean Expressions and Truth Tables, Standard SOP and POS forms; Minterm and Maxterms, Simplification of Boolean Expressions, Minimization Techniques for Boolean Expressions using Karnaugh Map.

Unit II :

Combinational Circuits

Adders Half-Adder and Full-Adder, Subtractors- Half and Full Subtractor; Parallel adder and Subtractor, Ripple Carry and Look-Ahead Carry Adders. BCD adder, BCD subtractor, Encoder, Decoder ,BCD to Seven segment Display Decoder, Comparators.

Sequential Circuits

Introduction to Sequential Circuits, Flip-Flops: Types of Flip Flops -RS, T, D, JK, Master-Slave JK.

Shift Registers

Introduction to shift registers, Basic Shift Register Operations, types of shift registers, Bidirectional Shift Registers, Shift Register Counters.

Unit III :

8086 Microprocessor

Assembly Language Programming, The 8086 microprocessor, Architecture of a microprocessor 8086, Pin Diagram of 8086, The Instruction format, The addressing mode, The type of Instructions, The need and use of assembly language, Input out in assembly language program, Input/ Output services, The assembly program tools.

Programming using Raspberry PI, Arduino.

Unit IV :**Introduction of Internet of Things**

Defining **Internet of Things**(IoT), Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs. Machine to Machine, Difference between IoT and M2M, Wireless medium access issues, MAC protocol survey, survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.

Challenges in IoT

Design challenges, Development challenges, Security challenges, Other challenges. Developing IoTs using Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.

Application of IoT

Home automation, Industry applications, Surveillance applications

Reading Material:

1. B. Ram, "Fundamentals of Microprocessors and Microcomputers", Dhanpat Rai Publications.
2. A.K.Ray and K.M.Bhurchandi – “Advanced Microprocessors & Peripherals” Tata McGraw Hill
3. Vijay Madiseti, ArshdeepBahga, “Internet of Things: A Hands-On Approach”
4. WalteneusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice
5. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1 st Edition, Apress Publications, 2013
6. CunoPfister, Getting Started with the Internet of Things, O“Reilly Media, 2011, ISBN: 978-1-4493- 9357-1

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - III (Theory Paper)

PSFSD304: Python Forensics

Hours per week – 04

Credits – 04

<p>Unit I :</p> <p>Why Python Forensics Introduction, Cybercrime investigation challenges, How can python programming environment help meet these challenges?, Daubert Evidence Standard,</p> <p>Setting up a Python Forensics Environment Python Packages and Modules, What is included in STD library, Third party packages and modules,</p> <p>First Python Forensic App Introduction, Naming and Consideration, One way File system hashing</p>
<p>Unit II :</p> <p>Forensic Searching and Indexing using python Introduction, Keyword Context search, indexing</p> <p>Forensic Evidence Extraction (JPEG & TIFF) Introduction</p> <p>Forensic Time Introduction, Adding time to the Equation, Time Module, The Network Time Protocol</p>
<p>Unit III :</p> <p>Networked Programs HTTP, urllib, Parsing HTML and scraping web, parsing HTML using RegExp, BeautifulSoup, reading binary files using urllib</p> <p>Network Forensic Part-I Network Investigation Basics, reverify range of targets, port scanning,</p> <p>Network Forensic Part-II Packet Sniffing, Raw Socket in python, Python Silent Network Mapping Tool.</p>
<p>Unit IV :</p> <p>Using python for Virtualization Forensic Virtualization as new surface of attack, Searching for misuse of virtual resource, Using virtualization as source evidence</p> <p>Using Python for mobile forensic The investigative model for smartphones, Android, Apple iOS</p> <p>Using Python for Memory forensic Understanding volatility basics, Using Volatility on Android, Using volatility on Linux</p>

Reading Material:

1. Chet Hosmer, “Python Forensics- A Workbench for Inventing and Sharing Digital Forensic Technology”, Syngress
2. Dr. Michael Spreitzen barth and Dr. Johann Uhrmann, “Mastering Python Forensics” ,Packt Publication
3. Preston Miller, Chapin Bryce, “Python Digital Forensics Cookbook-Effective Python recipes for digital investigations” ,Packt Publication
4. Charles Severance , “Python for Informatics”
5. Chet Hosmer, “Integrating Python with Leading Computer Forensics Platforms”, Syngress

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - III (Lab Course)

PSFSD P301: Lab Course -5

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Installation and configuration of KALI Linux
2. Installation Third party applications on KALI
3. Basic Reconnaissance using KALI Linux
4. Advanced Reconnaissance and Vulnerability Scanning using KALI Linux
5. Target Exploitation using KALI Linux
6. Post Exploitation activities using Kali Linux
7. Social Engineering
8. Exploiting Communication
9. XSS
10. SQL Injection
11. Basic python programs(Branching, looping, file handling)
12. File hashing with python
13. File system hashing with python
14. Evidence Searching with python-I
15. Evidence Searching with python-II
16. Meta data extraction using python-I
17. Meta data extraction using python-II
18. NTP client setup and applications
19. Accessing webpage with python
20. Assessing webpage in python (downloading media from webpage)
21. Assessing webpage in python (data extraction and processing)
22. Accessing webpage in python (accessing tags and finding potential useful information)
23. IP communication with python (TCP and UDP)
24. Network forensic with python-I Scanning
25. Network Forensic with python-II Packet analysis
26. Analyzing virtual environment in python
27. Analyzing mobile in python (2 Nos)
28. Memory forensic with python(2 Nos)

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - III (Lab Course)

PSFSD P302: Lab Course -6

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Simple programs in java
2. Branching , looping in java
3. File handling in java
4. Object oriented programming in java
5. Android Studio configuration
6. Simple program in android
7. Interactive programs in Android
8. Multi Activity programs in android
9. Persistence in Android
10. SQLite connectivity in android
11. Fetching web content in android
12. Analysis of evidences in mobile SIM cards, memory cards etc.
13. Call Details Record (CDR) analysis.
14. Internet Protocol Details Record (IPDR) analysis.
15. Tracking the present and past locations of a mobile phone.
16. Analysis of SQLite Databases.
17. Data Acquisition from Android Phones.
18. Analysis of extracted data in Android Phones.
19. Data Acquisition from iOS devices
20. Analysis of extracted data in iOS devices.
21. Password Cracking of Mobile Phones. .
22. Cracking password of Wi-Fi routers

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - IV (Theory Paper)

PSFSD401: Forensic Multimedia Sciences

Hours per week – 04

Credits – 04

<p>Unit I : Foundation to Multimedia Sciences Introduction to digital signals: audio, image and video; Digitization process: sampling and quantization; Image Enhancement Techniques: Spatial and frequency domain; Image Compression Techniques: Introduction, lossy and lossless compression, Run length coding, scalar and vector quantization, JPEG and JPEG 2000 compression techniques; Image description and representation techniques: Introduction, boundary descriptor: chain code and shape number, regional descriptor: color and texture descriptors ; Introduction to pattern clustering and classification.</p>
<p>Unit II : Introduction to Multimedia Forensics Introduction and scope of Multimedia Forensics; Basics of Multimedia; Devices for capturing image and video: digital camera and its components, acquisition process of digital image and video; Standards for video transmission; NTSC and PAL; Devices for capturing audio: dynamic and condenser microphones and its components; Standard and best practices in Multimedia Forensics; Admissibility of multimedia evidence to the court of law.</p>
<p>Unit III : Image and Video Forensics Introduction and scope of image and video forensics; Active and passive image/video forensics; Blind and non-blind image/video forensics; Methods of source camera identification: based on sensor and physical defects; Methods for tampering of digital image/video; Forensic authentication of digital image/video; Steganography and steganalysis; Enhancement of digital image/video.</p>
<p>Unit IV : Audio Forensics and Speaker Identification Introduction and scope of audio forensics; Methods of tampering for digital audio; Forensic authentication of digital audio; Microphone Forensics; Introduction and scope of speaker identification; Human vocal tract and production and description of speech sound; Forensic phonetics and phonetic transcription; Methods of speaker identification: auditory and spectrographic analysis; Automatic speaker identification system; Collection of voice samples: methods and challenges.</p>

Reading Material:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Prentice-Hall, Inc. Upper Saddle River, NJ, USA, 2006
2. Alan Bovik, Handbook of Image and Video Processing, Academic Press, USA, 2000
3. Husrev Taha Sencar and Nasir Memon, Digital Image Forensics: There is More to a Picture than Meets the Eye, Springer Science and Business Media, New York, 2013
4. Anthony T.S. Ho and Shujun Li, Handbook of digital forensics of multimedia data and devices, John Wiley & Sons, Ltd., UK, 2015.
5. Hany Farid, Photo Forensics, The MIT Press, Cambridge, First Edition, 2016
6. Philip Rose, Forensic Speaker Identification, CRC Press, 2002

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - IV (Theory Paper)

PSFSD402: Malware Analysis

Hours per week – 04

Credits – 04

<p>Unit I :</p> <p>Introduction to Malware Analysis Malware General Aspect of Computer infection program , Non Self Reproducing Malware, How does Virus Operate?, Virus nomenclature, Worm Nomenclature, Recent Malware Case Studies ,What Is Malware Analysis, Why Is Malware Analysis,Types Of Malware Analysis.</p> <p>Static Analysis Determining the File Type, Fingerprinting the Malware, Multiple Anti-Virus Scanning, Extracting Strings, Determining File Obfuscation, Inspecting PE Header information, Comparing And Classifying The Malware, Classifying Malware Using YARA ,Reverse engineering Android apps</p>
<p>Unit II :</p> <p>Dynamic Analysis Dynamic Analysis (Monitoring) Tools , Dynamic Analysis Steps, Analyzing a Malware Executable, Dynamic-Link Library (DLL) Analysis, Cuckoo Sandbox</p> <p>Disassembly How Data Resides In Memory, Program Compilation, Program On Disk, Program In Memory,Program Disassembly (From Machine code To Assembly code) ,Analyzing 32-bit Executable on 64-bit Windows, Disassembly Challenge, Disassembly Solution,</p> <p>Disassembly Using IDA Code Analysis Tools ,Static Code Analysis (Disassembly) Using IDA, Disassembling Windows API, Patching Binary Using IDA, IDA Scripting and Plug-ins</p>
<p>Unit III :</p> <p>Debugging Malicious Binaries General Debugging Concepts, Debugging a Binary Using x64dbg, Debugging a Binary Using IDA , Debugging a .NET Application</p> <p>Malware Functionalities and Persistence Malware Functionalities ,Malware Persistence Methods</p> <p>Code Injection and Hooking Virtual Memory,User Mode And Kernel Mode, Code Injection Techniques , Hooking Techniques</p>

Unit IV :**Malware Obfuscation Techniques**

Simple Encoding, Malware Encryption, Custom Encoding/Encryption, Malware Unpacking

Hunting Malware Using Memory Forensics

Memory Forensics Steps, Memory Acquisition, Volatility Overview, Enumerating Processes, Listing Process Handles, Listing DLLs, Dumping an Executable and DLL, Listing Network Connections and Sockets, Inspecting Registry, Investigating Service, Extracting Command History

Detecting Advanced Malware Using Memory Forensics

Detecting Code Injection, Investigating Hollow Process Injection, Detecting API Hooks, Kernel Mode Rootkits, Listing Kernel Modules, I/O Processing, Displaying Device Trees, Detecting Kernel Space Hooking, Kernel Callbacks And Timers

Reading Material:

1. Erci Filiol, "Computer Viruses: from theory to applications", Springer, 1st edition, 2005.
2. Monnappa K.A. , "Learning_Malware_Analysis: Explore the concepts, tools, and technique to analyze and investigate Windows malware", Packt Publishing Ltd, 1st edition, 2018
3. Michael Sikorski and Andrew Honig, "Practical Malware Analysis" ,No starch press- February, 2012.
4. Mark.A .Ludwig, "The Giant black book of computer viruses, CreateSpace Independent Publishing Platform, 2nd edition, 2009, ISBN 10: 144140712X
5. Ken Dunham , Shane Hartman, Jose Andre Morales, Manu Quintans , Tim Strazzere, "Android Malware and Analysis", CRC Press
6. Bruce Dang, Alexandre Gazet, Elias Bachaalany, Sébastien, "*Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation*", Wiley publication
7. Mobile Malware Attacks and Defense, Ken Dunham, Syngress Publishing, Inc., ISBN 978-1-59749-298-0

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - IV (Theory Paper)

PSFSD403: Principles of Secure Coding

Hours per week – 04

Credits – 04

<p>Unit I : Introduction A brief overview of Application Security and Secure Programming concepts. Secure Coding in C and C++, Stack overflow, Strings, Integers, Arrays, File I/O, Race conditions, Signal handling, Recommended Practice</p>
<p>Unit II : Secure Coding in Java and Web Applications Web as a primary vector for Cyber-attacks, Anatomy of attacks, data breach case studies, Threat modelling, Cross Site Scripting (XSS) vulnerabilities, Injection flaws (SQL, process, path etc.), Buffer overflows</p>
<p>Unit III : Resource leaks and resource lifetime management, Threat modelling and Security design review, Software Assurance and Testing-Software Assurance overview, Testing threat categories, Assessing Risk</p>
<p>Unit IV : Secure Testing Methodologies Attacking Dependencies, Attacking through the User Interface, Attacking Design, Attacking Implementation, Software engineering practices for development of high assurance code, Model Checking, Static Analysis techniques for analyzing software</p>

Reading Material:

1. Michael Howard , David LeBlanc, “Writing Secure Code”, Microsoft Press, 2nd Edition, 2003
2. Robert C. Seacord, “ Secure Coding in C and C++”, Pearson Education, 2nd edition, 2013
3. James A. Whittaker and Herbert H. Thompson, "How to Break Software Security", Addison Wesley, 2003
4. John C. Mitchell and Krzysztof Apt, "Concepts in Programming Languages", Cambridge University Press, 2001

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - IV (Theory Paper)

PSFSD404: Emerging Trends in Cyber Forensics

Hours per week – 04

Credits – 04

<p>Unit I : Introduction to Big Data and Hadoop Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.</p>
<p>Unit II: HDFS(Hadoop Distributed File System) The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures. Map Reduce: Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features</p>
<p>Unit III : Hadoop Eco System Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction</p>
<p>Unit IV : Data Analytics with R/Python/Spark and Big Data forensics Artificial Intelligence and Machine Learning : Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR/Python/Spark Big Data forensics : Big Data forensics ,The Hadoop forensic evidence ecosystem , Identifying Big Data Evidence, Collecting Hadoop Distributed File System Data, Collecting Hadoop Application Data, Performing Hadoop Distributed File System Analysis, Analyzing Hadoop Application Data, Presenting Forensic Findings</p>

Reading Material:

1. Tom White “ Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015
3. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.

4. Joe Sremack, "Big Data Forensics – Learning Hadoop Investigations", packt publication
5. Denis Rothman, "Artificial Intelligence By Example", Packt Publication
6. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
7. Venkat Ankam, "Big Data Analytics", packt publication
8. Sridhar All "Big Data Analytics with Hadoop 3", packt publication
9. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", packt publication
10. Arshdeep Bahga and VijayMadiseti, "Big Data Analytics: A Hands-On Approach",
11. Kai Hwang, Min Chen, "Big-Data Analytics for Cloud, IoT and Cognitive Computing", Wiley publication
12. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
13. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
14. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, 2010.
15. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers "CRC Press, 2015.
16. Jimmy Lin and Chris Dyer, "Data-Intensive Text Processing with MapReduce", Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010.
17. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
18. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press
19. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press.
20. Anand Rajaraman and Jeffrey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.
21. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
22. Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007
23. Pete Warden, "Big Data Glossary", O'Reily, 2011.
24. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, .
25. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", MC Press, 2012
26. Paul Zikopoulos, Dirk DeRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corigan, "Harness the Power of Big Data The IBM Big Data Platform", Tata McGraw Hill Publications, 2012

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - IV (Lab Course)

PSFSD P401: Lab Course - 7

Hours per week – 08

Credits – 04

(Minimum Twelve Experiments)

1. Set up a safe virtual environment to analyze malware
2. Quickly extract network signatures and host-based indicators
3. Use key analysis tools like IDA Pro, OllyDbg, and WinDbg
4. Overcome malware tricks like obfuscation, anti-disassembly, anti-debugging, and anti-virtual machine techniques
5. Use your newfound knowledge of Windows internals for malware analysis
6. Develop a methodology for unpacking malware and get practical experience with five of the most popular packers
7. Analyze special cases of malware with shell code, C++, and 64-bit code
8. Install Reanimator in your Windows machine and scan the system for Malware and prepare one report for the same.
9. Ransom ware Analysis
10. Analysis of mobile apps (2 nos)
11. Python program on cracking an encryption
12. To read and write a given image in Python/MATLAB
13. To perform histogram equalization of the given image in Python/MATLAB
14. To enhance the quality of image using contrast stretching techniques in Python/MATLAB
15. To remove salt-and-pepper noise in the given image using Python/MATLAB
16. To smooth the given image using Mean filter in Python/MATLAB
17. To apply low pass and high pass filters on the given image in Python/MATLAB
18. To extract frames of the given video in Python/MATLAB
19. To detect copy-move forgery in the given image/video frame
20. To detect splicing in the given image/video frame
21. To perform steganalysis of the given stego image.
22. To read and write a given audio file in Python/MATLAB
23. To detect splicing in the given audio
24. To perform auditory analysis of the given questioned and specimen voice samples
25. To perform spectrographic analysis of the given questioned and specimen voice samples
26. To prepare phonetic transcription of the given voice sample
27. Basic Data Analytic Methods using Python/R/Spark (4 nos)

M. Sc. FORENSIC SCIENCE
(Digital and Cyber Forensics and IT Security)
SEMESTER - IV (Lab Course)

PSFSD P402: Project

Hours per week – 08

Credits – 04

Project will be compulsory to all students. Students will carry out project work individually. Concerned department shall provide all required infrastructure to carry out project work. The format for project report will be similar to the research thesis style; incorporating chapters on: Introduction, Review of Literature, Materials and Methods, Results and Discussion and References / Bibliography. The Project report will be submitted in a typewritten and bound form. Students will present their work for evaluation. Copy of each project report will be submitted to the respective department. Project work on forensically significant and need based problems in the area(s) of Digital and Cyber Forensics, IT Security, Cyber Security, Computer Science/ Information Technology and other forensically important topics as per local, regional, national and international need.