DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD
SYLLABUS
Of
M.Sc. II (Semester III and IV)
(Forensic Science)

Effective from Academic Year
2013-2014 onwards
Preamble

M.Sc.-II (Sem-III & IV) (Forensic Science)

Ordinance ------------:- Title of the Program: - M.Sc.-II (Sem-III & IV) (Forensic Science)

Ordinance ------------:- Eligibility: - M.Sc.-I (Forensic Science)

Regulation no. ---------- : Specializations :- Four Specializations viz. Finger print and Questioned Document, Forensic Chemistry and Toxicology, Forensic Biology, Serology and DNA Finger Printing, Cyber Space, IT Security and Cyber Forensic may be offered subject to the availability of students as mentioned in the preceding Para/ regulation.

Regulation no. ----------:- Minimum intake capacity for each specialization: - There shall be minimum 25% of the intake capacity of the students for each specialization.

Regulation no. ---------- :- Allotment of specialization :- The specialization to the students will be allotted on the basis of choice and merit (M.Sc.-I) of the students. However, if the criterion of minimum intake capacity for a particular specialization as mentioned above 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.

Regulation no.---------- :- Course structure

Each semester will have four theory papers and two theory based practical papers. In the fourth semester students will carry out Dissertation instead of one practical paper. Each paper shall be of 75 marks.

Total Marks for M. Sc.-II (Forensic Science), III and IV Semester

<table>
<thead>
<tr>
<th>Semester</th>
<th>Theory (4 Papers per semester each of 75 marks)</th>
<th>Practical/ Dissertation (2 Papers per semester each of 75 marks)</th>
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**Specialization-II: Forensic Chemistry and Toxicology**

### Semester III

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<tr>
<th>Paper Code</th>
<th>Title</th>
<th>Hrs per week</th>
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<tbody>
<tr>
<td>MFSCT301</td>
<td>Analytical methods in forensic toxicology</td>
<td>4</td>
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<tr>
<td>MFSCT302</td>
<td>Spectroscopic instrumentation in forensic Analysis</td>
<td>4</td>
<td>75</td>
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<tr>
<td>MFSCT303</td>
<td>Separation techniques</td>
<td>4</td>
<td>75</td>
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<tr>
<td>MFSCT304</td>
<td>Trace evidences and it’s analysis</td>
<td>4</td>
<td>75</td>
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<tr>
<td>MFSCT305</td>
<td>Practical I</td>
<td>4/batch</td>
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<tr>
<td>MFSCT306</td>
<td>Practical II</td>
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### Semester IV

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<tr>
<td>MFSCT401</td>
<td>Functional toxicology</td>
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<tr>
<td>MFSCT402</td>
<td>Elemental instrumentation techniques</td>
<td>4</td>
<td>75</td>
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<tr>
<td>MFSCT403</td>
<td>Explosives and Drugs</td>
<td>4</td>
<td>75</td>
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<tr>
<td>MFSCT404</td>
<td>Forensic analysis of dyes, petroleum products, and fertilizers.</td>
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<td>75</td>
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<td>MFSCT405</td>
<td>Practical paper-III</td>
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<td>MFSCT406</td>
<td>Dissertation</td>
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Syllabus
Semester- III

Paper-I (MFSCT301): Analytical methods in forensic toxicology

Hrs/week-4 Marks-75

Unit I: Isolation and different methods of extraction: Isolation and purification of poison, different method of extractions for gases, volatile inorganics, volatile organics, nonvolatile inorganics, nonvolatile organics and anions, classical and modern methods, solvent extraction.

Unit II: Nature, Use, Administration, Symptoms, Post-mortem findings, Detection, Estimation and Toxicological materials of Arsenic, Cyanides, Copper Sulphate, Barbiturates, Organophosphorous compounds. Nature, Use, Administration, Symptoms, Post-mortem findings, Detection, Estimation and Toxicological materials of Vegetable Poisons: Opium, Dhatura, Oleander, Madar (AAK, AKDO) and animal poison like Snake Venom.

Unit III:
Methyl alcohol: Nature, use, administrations, symptoms, post-mortem findings, fatal dose, fatal period, isolation, detection, estimation.

Unit IV:
Toxicological material, other poisons include Aconite, Barium Carbonate, Cannabis, Caustic Alkali, Chloral Hydrate, Cyanogenic Glycosides, Ergot, Kuchila, Lead Salts, Mercury Salts, Mushrooms, Mechanical Poisons, Nicotine, Oxalic Acid, Quinine, Sodium Nitrite, Mineral Acids, Zinc Phosphide.

Unit V:
Extraction of poisons from blood, urine, stomach washes and vomits, cold drink, food material, toxicological analysis of decomposed materials. Interpretation of toxicological finding and preparation of reports, limitation of method and trouble shooting in toxicological analysis, disposal of analysis samples, some interesting and their importance in view of specific approach in examination.

Paper-II (MFSCT302): Spectroscopic instrumentation in forensic analysis

Hrs/week-4 Marks-75
Unit I: UV/VIS-Spectroscopy: Introduction, UV-Visible spectroscopy- Fundamental laws of spectrophotometry, Deviation from Beer’s Law, Instrumentation and techniques, qualitative and quantitative methods in UV-Visible spectroscopy, Forensic applications.

Unit II: IR-Spectroscopy: Introduction, Principle of FTIR, Modes/types of vibrations, functional group and fingerprint region, Review of IR spectroscopy, Dispersive and Nondispersive IR spectrophotometers, Fourier transform IR spectrophotometers, Instrumentation and Techniques, Interpretation of IR spectra, Forensic applications.

Unit III: NMR-Spectroscopy: Introduction, Nuclear Spin States, Resonance, Basic principle, Chemical Shift and Shielding effect, Chemical equivalence, Spin-spin splitting (n+1 Rule), Problem based on NMR, Forensic analysis by NMR tools.

Unit IV: Mass Spectrometry: Introduction, Review of Mass spectrometry, Basic Principles and Theory, Instrumentations and technique, Ionization methods, Fragmentations in Mass spectrometry, selected ion monitoring.

Unit V: Atomic mass spectrometry, Fast atom Bombardment mass spectrometry, stable Isotope ratio mass spectrometry, Tandem mass spectrometry, Forensic applications. Atomic spectrometry energy dispersive X-ray fluorescence spectrometry (ED-XRF)

Paper-III (MFSCT303): Separation Techniques

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<th>Hrs/week</th>
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Unit I: Basic concepts in analytical, qualitative and quantitative methods; errors, precision, and accuracy; Sampling techniques, processing the samples for analysis. Extraction and purification of analytes.

Unit II: Chromatography: Introduction, Review of basic principles and types of chromatography. TLC and HPTLC: Principle, Theory and instrumentation, visualization, Qualitative and Quantitative concepts and Forensic applications.

Unit III: Gas Chromatography: Principles, theory, instrumentations and technique, columns, stationary phases, detectors, Pyrolysis GC, GC-MS and its Forensic applications. HPLC: Theory, Instrumentation Technique, column, detectors, with special reference to LC-MS, Forensic applications.

Unit IV: Column chromatography: Principle, technique, column packing material, Selection of solvents, column preparation and loadings, Column efficiency, Flash chromatography, Forensic applications.

Unit V: Paper Chromatography: Principle, technique, Selection of solvents, preparation of samples and loading, Separation of various metal ions, Forensic Applications.
Unit I: Pigments: Introductions, white pigments, Manufacturing process and properties of blue pigment, red pigment, green pigment, yellow pigment. Paints: Introduction, Constituent of paint, manufacture of paints, requirement of good paints, paints failure, different type of paints, collection, preliminary analysis of paint samples, interpretations, Forensic application.

Unit II: Ceramic: Introduction, classification, porous and non-porous materials wastes, clay and its properties, primary and secondary clays. Manufacturing process, glass ceramics, forensic detection of ceramic and cement material.

Unit III: Cement: Cement, Concrete and Motar: Chemical compositions Portland cement, and other type of cements, building materials, Methods of samplings of cements, mortar and concrete Common adulterant of cement and their detection. Methods of analysis-Chemical analysis of cement, mortar and concrete, Instrumental method of analysis of by ICP, AAS and XRD.

Unit IV: Glass: Introduction, physical and chemical properties of glass, Methods of manufacture of glass, types of glasses, sodalime glass, lead or flint glass, borosilicate glass, glass fiber, aluminosilicate glass, alkali-barium silicate glass, colored glass, opal glass, safety glass, technical glass, glass ceramics, optical (Crookes) glass, sealing glass, Collection of glass sample, case study related to glass, forensic examination of glass.


Suggested readings for theory:
5. Arena Poisoning: Chemistry, Symptoms and Treatment.
15. Howard: Forensic Analysis by Gas Chromatography
17. Industrial chemistry: B.K. Sharma, Goel publishing house, Meerut.

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Paper-V (MFSCT305): Practical Paper-I

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<tr>
<th>Hrs/week-4</th>
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1. M.P, B.P and flash point determination (2 Nos.).
2. TLC, GC and GC-MS separation of anabolic steroids.
3. TLC, UV-Visible, HPLC Analysis of phenolphthalein in trap cases.
4. Analysis of alcohol content in sample by derivitization into known organic compounds and its analysis by GC, GCMS, HPLC.
5. Determination of Mercury in biological materials by spectrophotometry.
6. Analysis of animal and insect toxins
7. U.V/Vis spectrophotometric, GC and GC-MS analysis of barbiturates, benzodiazepine and amphetamines.
8. Detection of metallic poisons (arsenic and mercury) in viscera and food stuff (simulated samples).
9. Detection and identification of pesticide in a given formulation by colour test, TLC and UV-visible spectrometer
10. Identification of writing inks by TLC.
11. Spectrophotometric/ Colorimetric determination of nickel.

Paper-VI (MFSCT306): Practical Paper-II

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<th>Hrs/week-4</th>
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1. Estimation of paints and pigments by spectrophotometry (UV, FTIR, etc) (2 Nos.)
2. Comparison of polythene films by IR spectrophotometry.
3. Separation of sample of forensic interest by column chromatography as a separation technique.
5. Analysis of non-metallic (anionic) poisons in viscera.
6. Analysis of viscera for organochloro, organophosphoro, carbamates and pyrethroids by colour test TLC/HPTLC and UV-visible spectrometry method.
7. Determination of alcohol in blood and urine sample.
9. Analysis of blood, urine, stomach wash in emergency cases of poisoning.
10. Comparison of fibres by chemical analysis, TLC/HPTLC/ FTIR
11. Gas chromatography analysis of Ganja and Charas
12. Analysis of viscera and food material for in case of food poisoning by chemical, microscopic and instrumental techniques.

Suggested readings for practical:
1. Illustrated guide to home forensic science experiments by Rober B. Thompson and Barbara F. Thompson
7. Clerk’s Analysis of Drugs & Poisons VOL.-I & II; Clerke
8. Steroid analysis by HPLC; Marie P. Kautsky
Unit I: Food poisons: What is food poison, Food poisoning due to chemical, bacterial and fungal, Sign and symptoms of food poisoning, collection and preservation of evidence material, extraction and isolation, from food material, Biological material, detection and identification by colour test, and instrumental techniques.

Unit II: Management of toxicological cases in the hospital: Signs and symptoms of common poisons, antidotes. Collection and preservation of viscera for various types of poisons: Choice of preservatives, containers and storage.

Unit III: Metabolism and excretion of poisons: Introduction, Pathways of drug-metabolism-Non synthetic pathway or phase- I reactions like oxidation, hydroxylation, N-and –O de-alkylation and sulphoxide formation, Synthetic pathways or phase II reactions like conjugation, acetylation, methylation of drugs/poisons as exemplified by alcohols, aldehydes, ketones, aliphatic amines, carbamates, phenols, cyanides, barbiturates, amphetamines and opiates.

Unit IV: Toxicological Analysis
Identification of poisons by modern techniques: Chromatography, Mass Spectroscopy, Spectrophotometry, X-ray Diffraction, Neutron Activation Analysis (NAA), Scanning Electron Microscope (SEM), Radio Immuno Assay (RIA)

**Unit V:** Classification of matrices- Biological, non-biological and Viscera Different methods of extraction for volatile poisons of organic and inorganic nature: Solvent extraction, distillation /steam distillation, micro diffusion, dialysis, dry ashing, wet digestion, modified star-otto method, ammonium sulphate method, residue levels, toxic levels, and therapeutic levels, fatal levels of commonly encountered poisons in blood, urine and tissues.

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**Paper-II (MFSCT402): Elemental instrumentation techniques**

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**Unit I:** Neutron Activation Analysis: Introduction, Review, Basic theory and principles, Instrumentation-Various neutron sources, Detection and measurement of Gamma-rays for qualitative and quantitative analysis, Forensic Applications.

**Unit II:** X-ray Techniques: Introduction, Properties of X-Rays, Overview of various X-Ray techniques, X-ray Diffraction (XRD), X-ray Fluorescence (XRF), Energy dispersive EDXRF, Basic theory and principles, Instrumentation, Forensic applications.

**Unit III:** Flame Photometry: Introduction, General Principle, Instrumentation, Effects of solvents, Interference in flame photometry, Determination of non-metals, limitations, Forensic Applications.

**Unit IV:** Thermal Methods of Analysis: General introduction, classification of thermal methods of analysis, Thermo Gravimetry Analysis (TGA), principles, factors affecting thermal curve, Derivative thermogravimetry, Differential Thermal Analysis (DTA), factors affecting DTA curve, Differential Scanning Calorimetry (DSC), principles, instrumentation and applications, Microthermal analysis, thermomechanical and dynamic mechanical analysis, thermometric titrations, Forensic Application.

**Unit V:** Atomic Absorption Spectroscopy: Introduction, Basic principles, Instrumentation and Techniques, FAAS, Interference in AAS-Background correction methods, Forensic applications. Atomic Emission spectroscopy: Introduction, Principles and Instrumentation, Interferences and background correction, techniques, Graphite electrodes spark emission, Inductively Coupled Plasma atomic emission spectroscopy (ICP-AES), Forensic applications.

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**Paper-III (MFSCT403): Explosives and Drugs**

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**Unit I:** Explosives: Introduction, Temperature of chemical explosion, Force and pressure of explosion, Kinetics of explosive reactions. Development of explosives : Black powder, Nitro Cellulose, Nitro Glycerin, Dynamite, Ammonium nitrate, Commercial explosives (permitted
explosives, ANFO and slurry explosives), Military explosives (picric acid, tetry TNT, Nitro guanidine, PETN, RDX, HMX and polymer bonded explosives)

**Unit II**: Role of Forensic scientist in Post blast investigation, Disposal of bombs, Explosions effects, Collection of samples, Technical report frame work, Homemade crude bombs, Evaluation and assessment of explosion site and reconstruction of sequence of events., General methods of manufacture of explosives,

**Unit III**: Arson and Fire: Chemistry of fire, difference between Arson and Fire, Material and Chemicals use in initiating fire and arson Examination of scene of fire/arson recognition and collection of evidence, packing labeling and forwarding of exhibits, methods of extraction from exhibit- direct extraction, distillation and micro diffusion methods, analysis of arson exhibits by instrumental methods.

**Unit IV**: Analysis of illicit drugs and search of clandestine laboratory, precursors and their analysis, estimation of morphine in opium and heroin in smack, analysis of drugs in biological samples and their importance: Hair, urine, blood, viscera, methods of extraction of drugs/consultation of drugs, limitation of chemical analysis of drugs, report writing and interpretation of drugs.

**Unit V**: Method of analysis of acidic/ neutral drugs and poison in viscera: salicylic acid, benzoic acid, cannabinoids aspirin, meprobamate, barbiturates and methaqualone etc. Method of analysis of basic drugs and poisons from viscera: opium and its alkcoloids, atropine, strychnine, brucine, cocaine amphetamines, benzodiazepines, LSD, ketamine etc.

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**Paper-IV (MFSCT404): Forensic analysis of dyes, petroleum products and fertilizers.**

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**Unit I**: Dyes: Different type of dyes, role of dyes in crime investigation, food colours (edible and non-edible dyes), dyes used in cosmetic and pharmaceutical. Chemical analysis and instrumental methods of analysis of dyes.

Analysis of trace evidence: cosmetics, dyes, Trap related evidence materials, fibers, oils, fats, greases, industrial dusts, chemicals and plant material.

**Unit II**: Quantitative and qualitative forensic analysis of organic and inorganic Industrial products, chemical fertilizers, insecticides, metallic and non metallic products, consumer items such as gold, silver, tobacco, tea, sugars, salts, acids and alkalis etc.

Unit IV: Fertilizers: Introduction to fertilizer, different type of fertilizers and classification, substandard and sub-standard adulterated fertilizers, common adulterants. Chemical and instrumental methods of analysis of fertilizers.

Unit V: General principles: Solvents in analytical chemistry, concentration systems, stoichiometric calculation, acid-base titration, titration curves, acid base indicators, applications of acid-base titration, complexometric titration, metal-ion indicators, precipitation titration, Mohr’s titration, Volhard’s titration, adsorption indicators, Fajan’s titration, Forensic applications.

Suggested readings for theory:
2. Casarett & Doll Toxicology : The Basic Science of poisons.
9. Dubois and celling: Textbook of Toxicology.
17. Jehuda Yinon; Forensic and Environmental Detection of Explosives
Paper-V (MFSCT405): Practical paper-III

Hrs/week-4  Marks-75

(Minimum 12 Practical)

1. Thin layer chromatographic, GC and GC-MS analysis of NDPS drugs (2 Nos.)
2. Extraction and identification of acidic and basic drugs from viscera (simulated sample), TLC, GC and GC-MS
3. GC examination of arson products and alcohol.
4. Identification and comparison of explosives by FTIR.
5. Study of thermal behavior of hair and fibre threads, polymers and other materials by DSC, TGA (2 Nos.)
6. Comparison of component of cosmetic stain from crime scene and suspect is clothing by spectrophotometry method UV/FTIR.
7. Chemical analysis of given fertilizer by chemical test and instrumental techniques.
8. Analysis of dyes by TLC and UV-visible spectrometer.
9. Determination of poisonous metals in biological materials by AAS.
10. Extraction, Systematic identification of Narcotic Drugs and Psychotropic substances (opiates, cannabis and barbiturates, benzodiazepines and amphetamines) by spot colour tests
12. GC-MS, HPLC analysis of explosive residues.
13. Detection of adulteration in oils and fats by chemical analysis and TLC/ HPTLC.
14. Detection and identification of metallic poisons in viscera and food material by chemical test and instrumental technique.
15. Systematic extraction, and identification and non–volatile drugs and poisons by various techniques.
16. Study of the extraction methods of Drugs and poisons from viscera samples.
17. Visit to Forensic Science laboratory and preparation of report.

Paper-VI (MFSCT406): Dissertation

Hrs/week-4  Marks-75

Description
This course covers the application of analytical chemistry within the field of forensic science. Students learn the fundamental principles behind the analyses of chemical and physical evidence for drugs, combustion and arson, colorants, documents, and fibres. Qualitative analysis is presented by examining the chemical details of presumptive testing from a mechanistic approach. An analytical chemistry perspective is used to explain modern laboratory instrumentation and proper statistical treatment of collected data for quantitative analysis. An overview of chemical toxicology is covered with an emphasis on understanding biochemical pathways and pharmacokinetics.

Objectives
To introduce students to research in various areas of Forensic chemistry by engaging them to carry out a project under the supervision of a faculty. The main objective of this course is to teach students how to use critical thinking skills and fundamental scientific principles to approach and solve problems in forensic science. Students should learn how to create an unbiased sampling of evidence and select proper methods to process that evidence. Finally, students should be able to communicate and support the technical details of their findings in a clear, logical manner that can easily be understood in a court of law.

Suggested readings for practical:
3. Clerk’s Analysis of Drugs & Poisons VOL.-I & II; Clerke
5. Explosive (4th Rev.Ed); J.Kohler, Redolf)
6. Scientific protocols for fire investigation; John J. Lentini
7. TLC VOL.-II; Jork, Funk & Others
8. Practical Organic chemistry; Vogel