Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Science College
Semester-2(M.Sc)

**Subject:** Forensic Physics and Ballistics– MSCFS12509

**Type of course:** Major

**Prerequisite:** Basic understanding of physics (mechanics, motion, and energy), mathematics, and foundational knowledge of firearms and ammunition.

**Rationale:** Forensic Physics and Ballistics help in analyzing physical evidence and firearm-related materials to determine trajectories, impact dynamics, and the origins of projectiles, aiding in solving crimes with scientific precision.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | CA | |
| CI | T | P | C | ESE | MSE | V | P | ALA | |
| 4 | 0 | 0 | 4 | 60 | 30 | 10 | 00 | 50 | 150 |

*Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.*

**Course Content:**

| Unit No. | Course content | Hrs | % Weightage |
|---|---|---|---|
| 1 | **Unit I History and development of firearms:** Classification and characteristics, various components of small arms, smooth bore and rifled firearms, bore and caliber, shotgun barrels, chokes - their degrees and types; different automatic mechanisms used in small arms – blow back, recoil operated and gas operated mechanisms, rifling, class characteristics of rifled bore, purpose of rifling, methods to produce rifling; trigger and firing mechanism, trigger pull, accidental discharge of firearms, country-made firearms, improvised and imitation firearms. Types of ammunition, nomenclature, percussion caps and their types, | 15 | 25 |

| | | | |
|---|---|---|---|
| | various priming composition, propellants, types of cartridge cases, their heads, various types of bullets and their compositional aspects. Safety aspects about handling of firearms and ammunition. | | |
| 2 | **Unit II Physical evidence and Gun-Shot Residue:**<br>Physical evidence available in crime involving firearms, handling of physical evidence at crime scene, principles and practice of identification of firearms, class and individual characteristics, various marks on fired cartridge cases and bullets, test firings, techniques of obtaining test materials, comparison microscope and matching of marks on evidence and test exhibits, automated bullet-cartridge identification system – IBIS and NIBIN. Estimation of range of firing: burning, blackening, tattooing, spread of pellets, Walker"s test. Chemical tests of copper and lead around gunshot holes. Dermal nitrate test, why was it abandoned, mechanism of formation of gunshot residue, various methods of lifting of gunshot residue, detection of GSR by AAS. Gun-Shot Injuries – caused by shotguns, rifles, revolvers, pistols, evaluation of gunshot injuries. Knowledge of Arms Act. | 15 | 25 |
| 3 | **Unit – III Criminalistics and Forensic Engineering:**<br>Role of trace evidence analysis and source correspondence, Arson Investigation, Introduction to Nano-science Advanced Physical Techniques: Introduction to Lasers, Advanced microscopy & 3D scanning; Introduction to Atomic Absorption & Emission Spectroscopy, Fourier transform and X-ray spectroscopy Collision Investigation and Reconstruction: Causes and Prevention of Road Accidents, Liability to accidents, Communication on the road, Reconstruction and proactive measures. | 15 | 25 |
| 4. | **Unit – IV Forensic Voice Identification:**<br>Resonance and overtones. synthesis of complex waves, Place Theory of Hearing, Anatomy of Vocal Tract, Vocal Formants, analysis and recording of voice samples in trap/sting investigation Photography and Forensic Image analysis: Light and Illumination, Optics and Lenses, Zoom and close-up Photography, Introduction to forensic use of digital images, resolution, colour space, file formats, photo sensors, memory and media, computing images Forensic Video Analysis: Introduction to video, Video Cameras, Video images, Video Captures, CCTVs, Retrieval of images and their evidence analysis | 15 | 25 |

## Continuous Assessment:

| Sr. No | Active Learning Activities | Marks |
|---|---|---|
| 1. | **Firearm Classification Chart** Students create a chart categorizing different types of firearms (e.g., smooth bore, rifled firearms, automatic mechanisms) with descriptions of each category's characteristics and uses and upload it on GMIU web Portal. | 10 |
| 2. | **Range Estimation Scenario Analysis** Faculty will provide students with crime scene scenarios involving gunshot wounds, specifying the type of firearm used. Students will estimate the range of firing (using techniques like blackening, tattooing, spread of pellets) and explain their reasoning and then upload it on GMIU web Portal. | 10 |
| 3. | **Chemical Tests for Gunshot Residue Comparison** Faculty will provide case studies involving gunshot residue (GSR) detection. Students will write a procedure for testing for copper and lead around gunshot holes and compare methods like AAS and dermal nitrate tests and upload it on GMIU web Portal. | 10 |
| 4. | **Trace Evidence Analysis Report** Faculty will provide students with hypothetical case scenarios involving trace evidence (e.g., fibers, hair, paint). Students write a detailed report on the role of trace evidence analysis in identifying sources and matching evidence to a suspect or crime scene and upload it on GMIU web Portal. | 10 |
| 5. | **Vocal Tract Anatomy Diagram** Students draw and label the anatomy of the vocal tract, indicating key structures involved in voice production. They then write a brief explanation of how these structures contribute to unique voice characteristics and upload it on GMIU web Portal. | 10 |
| **Total** | | **50** |

## Suggested Specification table with Marks (Theory):60

| Distribution of Theory Marks (Revised Bloom's Taxonomy) | | | | | | |
|---|---|---|---|---|---|---|
| Level | Remembrance (R) | Understanding (U) | Application (A) | Analyze (N) | Evaluate (E) | Create (C) |
| Weightage | 25% | 30% | 30% | 10% | 5% | 00 |

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

## Course Outcome:

| After learning the course the students should be able to: | |
|---|---|
| CO1 | Analyze the significance of bore, caliber, and chokes in firearm design and performance. |
| CO2 | Estimate the range of firing using techniques like burning, blackening, and tattooing, and evaluate gunshot injuries. |
| CO3 | Recognize the role of proactive measures and effective communication in preventing road accidents and improving traffic safety. |
| CO4 | Apply forensic photography techniques, including the use of light, optics, and digital imaging, to capture and analyze forensic evidence. |

## Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

## Reference Books:

[1] Sharma, B.R.; "Firearms in Criminal Investigation & Trials", Universal Law Publishing Co Pvt Ltd, New Delhi, 4th Edition, 2011.
[2] Hatcher, Jury and Weller; "Firearms Investigation, Identification and Evidence", Stackpole Books, Harrisburg, Pa, 1997.
[3] Heard, B.J; "Handbook of Firearms and Ballistics", John Wiley, England, 1997.
[4] Jauhari M; "Identification of Firearms, Ammunition, & Firearms Injuries", BPR&D, New Delhi.
[5] Hogg, I.V; "The Cartridge guide – A Smallarms Ammunition Identification Manual", The Stackpole publishing Co., Harrisburg, Pa, 1982.
[6] Atkins, P.W.; "Physical Chemistry", 6th Edition, Oxford University, 1998.