POs / PSOs for M.Sc. (Chemistry) Program

Programme Outcomes (POs)

PO1	Acquire problem solving, initiative and enterprise skills that contribute to productive and innovative outcomes.
PO2	Develop and update domain knowledge relevant to the chosen field to succeed in highly competitive and rapidly changing work environments.
PO3	Prepare to utilize the acquired knowledge leading to innovation and entrepreneurship in order to eliminate the problems of the society.
PO4	Demonstrate the ability to design and conduct experiments, demos, create models to analyze and interpret data
PO5	Design and perform experiments related to scientific and computational theories and conceive potential technological applications.
PO6	Demonstrate ability for collaborative research and scientific communication through projects, internship and on-site training.
PO7	Conceive the ways and means to address various social, economic, environmental, human rights and other critical issues faced by humanity at the local, national and global levels.

Programme Specific Objectives (PSOs)

PSO 1	Demonstrate quality chemistry knowledge with solid fundamentals to understand and solve global problem
PSO 2	Exhibit professional efficiency as chemists, academicians and researchers.
PSO 3	Hold professional ethics as chemists, entrepreneurs in facing the challenges at the global level

Mapping of PSOs with the mission of the department

Key Components of Mission Statements	PSO		
	PSO1	PSO2	PSO3
Solutions to human problems	√	√	√
Academic Excellence	√	√	
Professional competence and exemplary values		√	√

M.Sc. (Chemistry) 2020-21 Batch
COURSE COMPONENTS

Sl. No	Course Code	Program Core (52 credits + Part Semester / Full semester project)	Credits
1	20CH3001	Chemical Kinetics and Chemical Thermodynamics	3:0:0
2	20CH3002	Theories of Chemical Bonding	3:0:0
3	20CH3003	Organic Reaction Mechanism and Stereochemistry	3:0:0
4	20CH3004	Statistical Thermodynamics and Quantum Chemistry	3:0:0
5	20CH3005	Coordination Chemistry of Transition Elements	3:0:0
6	20CH3006	Principles of Molecular Spectroscopy	3:0:0
7	20CH3007	Synthetic Reagents and Methodology	3:0:0
8	20CH3008	Group Theory and Applied Physical Chemistry	3:0:0
9	20CH3009	Organometallic and Bioinorganic Chemistry	3:0:0
10	20CH3010	Pericyclic Reactions and Biomolecules	3:0:0
11	20CH3011	Qualitative and Quantitative Organic Analysis Lab	0:0:4
12	20CH3012	Qualitative Analysis and Inorganic Preparation Lab	0:0:4
13	20CH3013	Physical Chemistry Lab	0:0:4
14	20CH3014	Inorganic Quantitative Analysis lab	0:0:2

15	20CH3015	Modern Instrumental Analysis Lab	0:0:2
16	20CH3016	Synthetic Organic Chemistry Lab	0:0:2
17	17VE3002	Value Education	0:0:2
18	20CH3061	Entrepreneurship and Business plan	2:0:0
		Total Credits	52
	PSP3998/ FSP3999	Part Semester Project (or) Full Semester Project	0:0:12 0:0:20
		Total	64/72

Sl. No	Course Code	Professional Electives (Minimum 12 credits to be earned)	Credits
1	20CH3017	Instrumental Methods of Chemical Analysis	3:0:0
2	20CH3018	Chemistry of non-transition elements	3:0:0
3	20CH3019	Nuclear Chemistry and Solid State Chemistry	3:0:0
4	20CH3020	Organic Spectroscopy	3:0:0
5	20CH3021	Supramolecular Chemistry and Green Chemistry	3:0:0
6	20CH3022	Applied Electrochemistry	3:0:0

Sl. No	Course Code	Other Electives	Credits
1	20CH3023	Research Methodology and IPR	3:0:0
2	20CH3024	Applied Polymer Chemistry	3:0:0
3	20CH3025	Laboratory Chemistry for the daily life	0:0:2
4	20CH3026	Forensic Chemistry	3:0:0
5	20CH3027	Advanced Photo and Electrocatalysis	3:0:0
6	20CH3028	Medicinal Chemistry	3:0:0
7	20CH3029	Photophysical Chemistry	3:0:0
8	20CH3030	Bioanalytical Chemistry and Biosensors	3:0:0
9	20CH3031	Nanomaterials Synthesis and Characterization	3:0:0
10	20CH3032	Stereoselective synthesis	3:0:0
11	20CH3033	Chemistry of Biofuels	3:0:0
12	20CH3034	Glass Forensic Science	3:0:0
13	20CH3035	Applied Chemical Crystallography	3:0:0
14	20CH3036	Chemistry of Carbenes	3:0:0
15	20CH3037	Metal-Organic Framework Materials	3:0:0
16	20CH3038	Advanced Main Group Chemistry	3:0:0
17	20CH3039	Chromatography	3:0:0
18	20CH3040	Water Treatment Technologies	3:0:0
19	20CH3041	Bioorganometallic Chemistry	3:0:0
20	20CH3042	Supramolecular Chemistry	3:0:0
21	20CH3043	Analytical Chemistry	3:0:0
22	20CH3060	Electrochemical Devices for Electric Vehicles	3:0:0

Credit Distribution

	Credits	
Core	52	
Professional Electives	12	
Other Electives	14/6	
Part Semester Project/ Full Semester project	12/20	To be offered in 4th Semester only
Total	**90**	

SEMESTER-WISE CURRICULUM

Sl. No		Course Code	Course Title	Credits
SEMESTER I				
1	Core	20CH3001	Chemical Kinetics and Chemical Thermodynamics	3:0:0
2	Core	20CH3002	Theories of Chemical Bonding	3:0:0
3	Core	20CH3003	Organic Reaction Mechanism and Stereochemistry	3:0:0
4	Core	20CH3011	Qualitative and Quantitative Organic Analysis Lab	0:0:4
5	Core	20CH3014	Inorganic Quantitative Analysis lab	0:0:2
6			Professional Elective 1	3:0:0
7			Professional Elective 2	3:0:0
8	Core	20CH3061	Entrepreneurship and Business plan	2:0:0
			Credits	**23**
SEMESTER II				
1	Core	20CH3004	Statistical Thermodynamics and Quantum Chemistry	3:0:0
2	Core	20CH3005	Coordination Chemistry of Transition Elements	3:0:0
3	Core	20CH3006	Principles of Molecular Spectroscopy	3:0:0
4	Core	20CH3007	Synthetic Reagents and Methodology	3:0:0
5	Core	20CH3012	Qualitative Analysis and Inorganic Preparation Lab	0:0:4
6	Core	20CH3015	Modern Instrumental Analysis Lab	0:0:2
7			Professional Elective 3	3:0:0
8			Value education	0:0:2
			Credits	**23**
SEMESTER III				
1	Core	20CH3008	Group Theory and Applied Physical chemistry	3:0:0
2	Core	20CH3009	Organometallic and Bioinorganic Chemistry	3:0:0
3	Core	20CH3010	Pericyclic Reactions and Biomolecules	3:0:0
4	Core	20CH3013	Physical Chemistry Lab	0:0:4
5	Core	20CH3016	Synthetic Organic Chemistry Lab	0:0:2
6			Professional Elective - 4	3:0:0
7			Other Elective 1	3:0:0
8			Other Elective 2	3:0:0
			Credits	**24**
SEMESTER IV				
1			Other Elective 3	3:0:0
2			Other Elective 4	3:0:0
3			Other Elective 5	0:0:2
4		PSP3998/ FSP3999	Part Semester Project (or) Full Semester Project	0:0:12/ 0:0:20
			Credits	**20**
			Total Credits	**90**

LIST OF NEW COURSES

S. No	Course Code	Course Title	Credits L:T:P:C			
1	20CH1001	Essentials of Chemistry for Aerospace Engineers	3	0	0	3
2	20CH1002	Applied Chemistry for Electrical and Computer Engineering	2	0	2	3
3	20CH1003	Applied Chemistry for Food Processing Technology	2	0	0	2
4	20CH1004	Applied Chemistry Laboratory for Food Processing Technology	0	0	3	1.5
5	20CH1005	Principles of Environmental Chemistry	3	0	0	3
6	20CH1006	Public Health Service Laboratory	0	0	2	1
7	20CH2001	Complementary Chemistry	3	0	0	3
8	20CH2002	Physical Chemistry Laboratory	0	0	3	2
9	20CH2003	Inorganic Chemistry for Forensic Science	3	0	0	3
10	20CH2004	Inorganic Chemistry Laboratory	0	0	3	2
11	20CH2005	Analytical Chemistry for Forensic Science	3	0	0	3
12	20CH2006	Organic Chemistry for Forensic Science	3	0	0	3
13	20CH2007	Instrumentation Techniques for Forensic Science	3	0	0	3
14	20CH2008	Analytical Chemistry Laboratory	0	0	3	2
15	20CH2009	Forensic Chemistry	3	0	0	3
16	20CH2010	Forensic Toxicology	3	0	0	3
17	20CH2011	Forensic Toxicology Laboratory	0	0	3	2
18	20CH2012	Crime Investigation Techniques	3	0	0	3
19	20CH2013	Nanochemistry for Forensic Science	3	0	0	3
20	20FS2001	Fundamentals of Forensic Science	3	0	0	3
21	20FS2002	Crime and Society	3	0	0	3
22	20FS2003	Forensic Physics	3	0	0	3
23	20FS2004	Fundamentals of Forensic Science Laboratory	0	0	3	2
24	20FS2005	Indian Constitution, Fundamental Laws and Procedure	4	0	0	4
25	20FS2006	Forensic Dermatoglyphics	3	0	0	3
26	20FS2007	Forensic Science Laboratory	0	0	3	2
27	20FS2008	Forensic Science & Criminal Justice System	3	0	0	3
28	20FS2009	Forensic Physics Laboratory	0	0	3	2
29	20FS2010	Cyber Forensics Laboratory	0	0	3	2
30	20FS2011	Questioned Documents	3	0	0	3
31	20FS2012	Questioned Documents Laboratory	0	0	3	2
32	20FS2013	Forensic Dermatoglyphics Laboratory	0	0	3	2
33	20FS2014	Forensic Biology and Serology -I	3	0	0	3
34	20FS2015	Forensic Biology and Serology Laboratory	0	0	3	2
35	20FS2016	Forensic Ballistics	3	0	0	3
36	20FS2017	Forensic Ballistics Laboratory	0	0	3	2
37	20FS2018	Moot Court for Forensic Science	0	0	3	2
38	20FS2019	Cyber Crimes and Cyber Forensic	3	0	0	3
39	20FS2020	Fundamentals of Forensic Psychology	3	0	0	3
40	20FS2021	Crime Scene Investigation	3	0	0	3
41	20FS2022	DNA Typing	3	0	0	3
42	20FS2023	Forensic Medicine	3	0	0	3
43	20FS2024	Forensic Anthropology and Odontology	3	0	0	3
44	20FS2025	Accident Investigation	3	0	0	3
45	20FS2026	Forensic Biology And Serology -II	3	0	0	3
46	20FS2027	Modern Techniques In Explosives and Bomb Detection	3	0	0	3
47	20FS2028	Foundation Course on Computer Fundamentals and Office	3	0	0	3

48	20CH3001	Chemical Kinetics and Chemical Thermodynamics	3	0	0	3
49	20CH3002	Theories of Chemical Bonding	3	0	0	3
50	20CH3003	Organic Reaction Mechanism and Stereochemistry	3	0	0	3
51	20CH3004	Statistical Thermodynamics and Quantum Chemistry	3	0	0	3
52	20CH3005	Coordination Chemistry of Transition Elements	3	0	0	3
53	20CH3006	Principles of Molecular Spectroscopy	3	0	0	3
54	20CH3007	Synthetic Reagents and Methodology	3	0	0	3
55	20CH3008	Group Theory and Applied Physical Chemistry	3	0	0	3
56	20CH3009	Organometallic and Bioinorganic Chemistry	3	0	0	3
57	20CH3010	Pericyclic Reactions and Biomolecules	3	0	0	3
58	20CH3011	Qualitative and Quantitative Organic Analysis Lab	0	0	6	4
59	20CH3012	Qualitative Analysis and Inorganic Preparation Lab	0	0	6	4
60	20CH3013	Physical Chemistry Lab	0	0	6	4
61	20CH3014	Inorganic Quantitative Analysis lab	0	0	3	2
62	20CH3015	Modern Instrumental Analysis Lab	0	0	3	2
63	20CH3016	Synthetic Organic Chemistry Lab	0	0	3	2
64	20CH3017	Instrumental Methods of Chemical Analysis	3	0	0	3
65	20CH3018	Chemistry of non-transition elements	3	0	0	3
66	20CH3019	Nuclear Chemistry and Solid State Chemistry	3	0	0	3
67	20CH3020	Organic Spectroscopy	3	0	0	3
68	20CH3021	Supramolecular Chemistry and Green Chemistry	3	0	0	3
69	20CH3022	Applied Electrochemistry	3	0	0	3
70	20CH3023	Research Methodology and IPR	3	0	0	3
71	20CH3024	Applied Polymer Chemistry	3	0	0	3
72	20CH3025	Laboratory Chemistry for the daily life	0	0	3	2
73	20CH3026	Forensic Chemistry	3	0	0	3
74	20CH3027	Advanced Photo and Electrocatalysis	3	0	0	3
75	20CH3028	Medicinal Chemistry	3	0	0	3
76	20CH3029	Photophysical Chemistry	3	0	0	3
77	20CH3030	Bioanalytical Chemistry and Biosensors	3	0	0	3
78	20CH3031	Nanomaterials Synthesis and Characterization	3	0	0	3
79	20CH3032	Stereoselective synthesis	3	0	0	3
80	20CH3033	Chemistry of Biofuels	3	0	0	3
81	20CH3034	Glass Forensic Science	3	0	0	3
82	20CH3035	Applied Chemical Crystallography	3	0	0	3
83	20CH3036	Chemistry of Carbenes	3	0	0	3
84	20CH3037	Metal-Organic Framework Materials	3	0	0	3
85	20CH3038	Advanced Main Group Chemistry	3	0	0	3
86	20CH3039	Chromatography	3	0	0	3
87	20CH3040	Water Treatment Technologies	3	0	0	3
88	20CH3041	Bioorganometallic Chemistry	3	0	0	3
89	20CH3042	Supramolecular Chemistry	3	0	0	3
90	20CH3043	Analytical Chemistry	3	0	0	3
91	20CH3044	Essentials of Forensic Chemistry	3	0	0	3
92	20CH3045	Forensic Tools and Techniques	3	0	0	3
93	20CH3046	Instrumental Methods of Analysis - I	3	0	0	3
94	20CH3047	Advanced Forensic Toxicology and Pharmacology	3	0	0	3
95	20CH3048	Instrumental methods of analysis - II	3	0	0	3
96	20CH3049	Forensic Chemistry Lab	0	0	3	2
97	20CH3050	Forensic Tools and Techniques Lab	0	0	3	2
98	20CH3051	Forensic Toxicology Lab	0	0	3	2
99	20CH3052	Instrumental Analysis Lab	0	0	3	2

100	20CH3053	Modern Instrumental Analysis Lab	0	0	3	2
101	20CH3054	Biochemistry and Biochemical Applications	3	0	0	3
102	20CH3055	Standards, Quality Management, Laboratory Management and Safety	3	0	0	3
103	20CH3056	IPR, Ethics and Research Methodology	3	0	0	3
104	20CH3057	Forensic Analysis of Drugs	3	0	0	3
105	20CH3058	Advanced Pharmaceutical Toxicology	3	0	0	3
106	20CH3059	Analytical Forensic Toxicology	3	0	0	3
107	20CH3060	Electrochemical Devices for Electric Vehicles	3	0	0	3
108	20CH3061	Entrepreneurship and Business Plan	2	0	0	2
109	20FS3001	Forensic Science and Criminal Justice System	3	0	0	3
110	20FS3002	Forensic Physics and Advanced Ballistics	3	0	0	3
111	20FS3003	Forensic Biology	3	0	0	3
112	20FS3004	Advanced Questioned Documents	3	0	0	3
113	20FS3005	Finger Prints and other Impressions	3	0	0	3
114	20FS3006	Crime Scene Management Lab	0	0	3	2
115	20FS3007	Forensic Physics and Ballistics Lab	0	0	3	2
116	20FS3008	Questioned Documents and Finger Print Analysis Lab	0	0	3	2
117	20FS3009	Cyber Crime	3	0	0	3
118	20FS3010	Forensic Psychology	3	0	0	3
119	20FS3011	Forensic Serology and Molecular Genetics	3	0	0	3
120	20FS3012	Forensic Phonetics, Voice Analysis and Speaker Recognition	3	0	0	3
121	20FS3013	Microscopy in Forensic Science	3	0	0	3
122	20FS3014	Biological Instrumental Methods	3	0	0	3
123	20FS3015	Statistics and Forensic Applications	2	0	0	2
124	20FS3016	Molecular Biology & Immunology	3	0	0	3
125	20FS3017	Medical Jurisprudence	3	0	0	3
126	20FS3018	Human Anatomy, Physiology and Forensic Medicine	3	0	0	3

20CH1001	**Essentials of Chemistry for Aerospace Engineers**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

Enable the students to

1. conversant with the fundamentals of atomic structures
2. develop curiosity towards fuels, energy resources and storage devices
3. acquire knowledge about spectroscopy

Course Outcomes:

The Student will be able to

1. formulate atomic structures and correlate its properties
2. realize the potential applications of protective coating
3. relate the unique properties of fuels
4. analyze the combustion process of common fuels
5. learn the various energy storage systems and conversion devices
6. describe the techniques involved in spectroscopy.

Module 1: **Atomic structure (8 Hours)**

Introduction, dual nature of electron, Heisenbergs uncertainty principle, quantum mechanical model of an atom, wave mechanical model of hydrogen atom, concept of atomic orbital's, electron spin, Pauli Exclusion Principle.

Module 2: **Protective coatings (7 Hours))**

Introduction, metallic coating, electroplating and its methods, electroless plating, organic coating, paints, analysis of oils, formulation of paints, failure of paint films, enamels, Varnishes, lacquers, emulsion paints, high temperature paints, special paints

Module 3: Fuels and combustion (7 Hours))

Fuels-classification, Characteristics of good fuel, calorific value, bomb calorimeter, - Proximate analysis of coal and its significance- -Knocking-octane number, cetane number, antiknocking characteristics of petrol, cracking, synthetic petrol, refining of gasoline, diesel, kerosene, biomass - Biogas-production, Flue Gas Analysis Orsat Method

Module 4: Explosives and propellants (7 Hours))

Introduction to explosives, classification of explosives, primary explosives, low explosives, high explosives, precautions during storing of explosives, blasting fuses, rocket propellants, classification of propellants.

Module 5: Energy sources and storage devices (8 Hours))

Redox reactions electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries dry cell -Lead acid battery - Fuel cell - Solar battery- Electrochemical sensors -Relationship between electrical energy and heat energy Gibbs Helmholtz equation, Photovoltoics

Module 6: Spectroscopy (8 Hours))

Introduction, types of energy present in molecules, general features of absorption spectrometer, infrared spectra, Frank Condon principle, UV and visible spectra, microwave spectroscope, Nuclear magnetic spectroscopy, Raman spectroscopy, flame photometer, Atomic absorption spectroscopy, mass spectroscopy.

Content beyond syllabus

Prepare a high temperature paint with Nano-additives and determine its heat transfer rate or any other topic from the syllabus.

Text Books:

1. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, "University Chemistry", 4th edition, Pearson, 2009

Reference Books:

1. Sienko M. J. and Plane R. A., "Chemistry: Principles and Applications", 3rd Edition, McGrawHill, 1980
2. Tembe B. L., Kamaluddin and M. S. Krishnan, "Engineering Chemistry" (NPTEL Web-book)
3. Atkins P. W and Julio de Paula "Physical Chemistry", 8th Edition, Oxford University press, 2007

20CH1002	Applied Chemistry for Electrical and Computer Engineering	L	T	P	C
		2	0	2	3

Course Objectives

Enable the students to

1. apply the properties of nanomaterials in electrical engineering
2. familiarize with energy storage devices and corrosion coatings
3. describe the importance of liquid crystals

Course Outcomes

The students will be able to

1. summarize the importance of electrochemical cells
2. describe various types of corrosion
3. apply various corrosion control methods
4. summarize various types of energy storage devices
5. infer the importance of liquid crystalline materials
6. discuss the importance of nanomaterials

Module 1: Electrochemistry (5 Hours)

Redox reactions, electrode potential, Nernst Equation, Electrochemical series and significance, Electrochemical cell – EMF of an electrochemical cell – Potentiometric titration

Module 2: Corrosion and Types: **(5 Hours)**

Definition – Consequences of corrosion - Dry Corrosion – types – mechanism – Wet corrosion – Mechanism – Galvanic corrosion – concentration cell corrosion – passivity – Pitting corrosion - Galvanic series

Module 3: Factors affecting Corrosion and Control Methods (5 Hours)

Factors influencing corrosion - Nature of metal –Nature of the environment - Corrosion control methods –Proper designing – using metals – metal alloys – cathodic protection – modifying the environment – Use of inhibitors – Application of protective coatings - Organic coatings

Module 4: Energy sources and storage devices (5 Hours)

Batteries – types – Primary cells - Dry batteries – Secondary cell - Lead acid batteries- Hydrogen – fuel cells – Microbil fuel cells - Solar battery – photovoltaics - -Electrochemical sensors

Module 5: Liquid Crystals (5 Hours)

classification, thermotropic and Lyotropic liquid crystals, Applications of liquid crystals – Liquid crystal display – Importance of lyotrophic liquid crystals – Application of grapheme oxide liquid crystal in energy storage – Liquid crystalline semiconductor materials

Module 6: Nanomaterials (5 Hours)

Nanomaterials – Classification –Top down and Bottom up Approaches – ball milling - microfabrication - characterization of nanomaterials – Introduction to XRD, SEM -Applications of nanomaterials - Nano-electronics - Nanostructured Solar Cells - Advantages.

LIST OF EXPERIMENTS (Any 8)

1. Estimation of copper in an alloy
2. Determination of percentage of nickel in an alloy
3. Evaluation of corrosion inhibition by weight loss method
4. Measurement of electrode potentials of metals/alloys
5. Construction of a Galvanic cell
6. Preparing batteries from fruits and vegetables
7. Determination of iron by potentiometry
8. Estimation of an acid by conductometry
9. Preparation of nanoparticles
10. Preparation of nanoparticles in polymer matrix
11. Measurement of pH
12. Determination of Melting point and boiling point

Text Books:

1. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, "University Chemistry", 4th edition, Pearson, 2009
3. Jones R. M., "Mechanics of Composite Materials", Hemisphere Publishing Corporation, New York
4. Elias, A. J., A Collection of Interesting General Chemistry Experiments, Revised Edition, Universities Press, 2007

Reference Books:

1. Sienko M. J. and Plane R. A., "Chemistry: Principles and Applications", 3rd Edition, McGrawHill, 1980
2. Tembe B. L., Kamaluddin and M. S. Krishnan, "Engineering Chemistry" (NPTEL Web-book)
3. Atkins P. W and Julio de Paula "Physical Chemistry", 8th Edition, Oxford University press, 2007
4. Chawla, K. K., "Composite Materials, Science and Engineering", ISBN: 978-0-387- 74365, Springer.
5. Daniel, I. M. and Ishai O., Engineering Mechanics of Composite Materials, Oxford University Press, 2nd Edition, 2005.

20CH1003	Applied Chemistry for Food Processing Technology	L	T	P	C
		2	0	0	2

Course Objectives

Enable the students to

1. summarize the importance of polymers and colloids in food processing technology
2. familiarize with nanomaterials and composites
3. discuss about renewable batteries and characterization techniques

Course Outcomes

The students will be able to

1. categorize various types of polymers used in food processing technology
2. describe the applications of colloids in food processing
3. summarize the use of nanomaterials in food processing technology
4. apply the nanocomposites in food processing technology
5. describe the use of bio-batteries
6. discuss about the characterization techniques of biomolecules

Module 1: Polymers for Food Processing (5 Hours)

Introduction - thermosetting plastics - thermoplastics- ingredients used in compounding of plastics — Polymers in Food processing industries – Characteristics – Plastics in Food Technology - Examples - Polytetrafluoroethylene (PTFE)- Poly ether ether ketone (PEEK)

Module 2: Food Colloids (5 Hours)

Colloids – types – Micelles - application of colloids in food industry – food hydrocolloids - classification-colloidal medicines

Module 3: Nanomaterials for food processing and preservation (5 Hours)

Nanomaterials – Classification –Top down and Bottom up Approaches – ball milling - microfabrication - - Fullerenes – carbon nanotubes –-Applications in food technology – edible coating –-encapsulation –

Module 4: Application of composites in Food Processing Technology (5 Hours)

Composite materials - Constituents – Classification - Advantages of Composites materials — Applications – Difference between Alloys and composites – nanocomposites – types (ceramic matrix, polymer-matrix, metal-matrix) -– Composites for food packaging – reducing food spoilage -examples

Module 5: Renewable energy for food preservation (5 Hours)

Batteries – types - Dry battery – Lead acid battery – Hydrogen – Oxygen Fuel Cells– Bio-mass – Bio-gas - Bio-battery – working principles – Enzymatic bio-battery - Microbial bio-battery – Applications – Generating renewable energy from food waste using bio-battery

Module 6: Spectroscopic techniques for food analysis (5 Hours)

Electromagnetic spectrum – Spectroscopic techniques – Applications of electronic and vibrational spectroscopy in characterization of food analysis

Text Books:

1. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, "University Chemistry", 4th edition, Pearson, 2009
3. Rath, P, "Engineering Chemistry", Cengage Learning, 2015

Reference Books:

1. Gutiérrez, T. J, "Polymers for Food Applications" Springer International Publishing, 2018
2. Gao, Y, Mohammadifar, M and Choi, S, "From Microbial Fuel Cells to Biobatteries: Moving toward OnDemand Micropower Generation for Small Scale Single Use Applications", Advanced Materials Technologies, 2019, 190079, DOI:10.1002/admt.201900079
3. Tembe B. L., Kamaluddin and M. S. Krishnan, "Engineering Chemistry" (NPTEL Web-book)
4. Chawla K. K, "Composite Materials-Science and Engineering", Springer, 2019 ISBN: 978-3-030-28982-9
5. Banwell, C. N, "Fundamentals of Molecular Spectroscopy", 4th Edition, Tata McGraw-Hill India Ltd, 2010

20CH1004	Applied Chemistry Laboratory for Food Processing Technology	L	T	P	C
		0	0	3	1.5

Course Objectives

Enable the students to

1. perform quantitative estimation of biomolecules
2. demonstrate experiments based on electrochemical techniques
3. synthesize and characterize nanomaterials

Course Outcomes

The students will be able to

1. demonstrate the spectroscopic techniques of analysis

2. quantitative estimation of biomolecules
3. prepare nanomaterials
4. analyze samples using electrochemical techniques
5. separate compounds using chromatographic techniques
6. perform conductance based experiments

LIST OF EXPERIMENTS

1. Qualitative tests for carbohydrates
2. Quantitative method for amino acid
3. Quantitative method for protein estimation
4. Quantitative method for cholesterol estimation
5. Synthesis of biodiesel from vegetable oil
6. Preparing batteries from fruits and vegetables
7. Estimation of nucleic acids by absorbance at 260 nm and its hyperchromic effect.
8. Determination of iron by potentiometry
9. Estimation of iron by spectrophotometry
10. Construction of a Galvanic cell
11. Analysis of Water
12. Investigation of biodiesel fuel and petroleum based fuel using IR spectroscopy
13. Extraction of lipids and analysis by paper chromatography and TLC.
14. Determination of free fatty acid content in fats and oils
15. Qualitative and quantitative estimation of adulterant in common food items
16. Estimation of non nutritive sweeteners
17. Estimation of effects of antioxidants usage in foods.
18. Observation of the effect of anticaking agents in foods.
19. Estimation of thickeners and their effects in foods.
20. Measurement of electrode potentials of metals/alloys

(Minimum 10 Experiments to be conducted)

Text Books:

1. Elias A. J., "A Collection of Interesting General Chemistry Experiments", Revised Edition, Universities Press, 2007
2. Khosla, B. D., Garg, V. C., and Gulati, A. R., "Senior Practical Physical Chemistry" Chand & Co.: New Delhi, 2011.
3. Garland, C. W.; Nibler, J. W. and Shoemaker, D. P., "Experiments in Physical Chemistry", 8th Edition, McGraw-Hill, New York, 2003.
4. Halpern, A. M. and McBane G. C., "Experimental Physical Chemistry", W.H. Freeman & Co. New York, 2003.
5. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017

20CH1005	Principles of Environmental Chemistry	L	T	P	C
		3	0	0	3

Course Objectives

Enable the students to

1. develop to understand the water technology, waste water and its treatment
2. conversant with the fundamentals of Corrosion and corrosion control
3. acquire knowledge about solid waste management

Course Outcome

Students will be able to

1. understand the various factors in water quality
2. learn the various water purification process and their applications
3. describe the process of corrosion
4. identify the methods to control corrosion
5. analyze the components present in cement
6. realize the solid waste management applications

Module 1: Water Technology (8 Hours)

Sources of water – Impurities in water - Hardness, Units and calculation of hardness – Determination of hardness by EDTA method -Disadvantages of water – Scales – Sludges – Internal conditioning – Calgon& carbonate conditioning In Caustic embrittlement – causes (DO, CO_2, acids) & removal methods – Alkalanity – Calculation of alkalinity – Determination of dissolved oxygen – water borne diseases

Module 2: Water Treatment (7 Hours)

Unit operations and processes - principle and functions of flash mixers, flocculators, sedimentation tanks, filtration, aeration, disinfection - distribution network - water softening. - Desalination – Electrodialysis - Reverse Osmosis

Module 3: Waste Water Treatment (7 Hours)

Layout of municipal wastewater treatment plant, physical unit operation – screening - flow equalization - flocculation, sedimentation - chemical precipitation - aerobic and anaerobic treatment process –sewage treatment plant (stp) - septic tank.

Module 4: Corrosion and its control (8 Hours)

Dry Corrosion – Oxidation corrosion – mechanism – Wet corrosion – Mechanism – Galvanic corrosion – Galvanic series – Factors influencing corrosion - Corrosion control methods

Module 5: Cement and its effects on Environment (8 Hours)

Cement – Introduction – classification, Portland cement – Manufacture – Properties, Chemical composition of cement -Setting and Hardening of Portland cement –-. Special cements – CO_2 emission from cement manufacturing and its effect on the environmental pollution

Module 6: Solid Waste Management (7 Hours)

Municipal solid waste (MSW) - composition and various chemical and physical parameters of MSW - Effects of solid waste on environment

Text Books:

1. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, "University Chemistry", 4th edition, Pearson, 2009
3. Jones R. M., "Mechanics of Composite Materials", Hemisphere Publishing Corporation, New York

Reference Books:

1. Sienko M. J. and Plane R. A., "Chemistry: Principles and Applications", 3rd Edition, McGrawHill, 1980
2. Tembe B. L., Kamaluddin and M. S. Krishnan, "Engineering Chemistry" (NPTEL Web-book)
3. Chawla, K. K., "Composite Materials, Science and Engineering", ISBN: 978-0-387- 74365, Springer. (2012),
4. Daniel, I. M. and Ishai O., "Engineering Mechanics of Composite Materials", Oxford University Press, 2nd Edition, 2005.

20CH1006	Public Health Service Laboratory	L	T	P	C
		0	0	2	1

Course Objectives

Enable the students to

1. Analyze the water properties
2. Utilize electrochemistry based experiments
3. Estimate the amount of an analyte in asample

Course Outcomes

The students will be able to

1. perform experiments related water analysis
2. perform conductance based experiments
3. demonstrate the spectroscopic techniques of analysis
4. quantitative estimation of analyte present in a sample
5. investigate an unknown compound
6. perform corrosion related experiments

List of Experiments

1. pH in given sample
2. Electrical conductivity and Total Dissolved Solids (TDS).
3. Total solids and settable solids present in given sample
4. Alkalinity in given sample
5. Acidity in given sample
6. Turbidity and optimum coagulant dose of a sample from jar test experiment
7. Hardness in given sample
8. Chlorides in given sample
9. Dissolved Oxygen (DO) and Bio-chemical Oxygen Demand (BOD) for given sample
10. Chemical Oxygen Demand (COD)
11. Sulphates present in sample
12. Estimation of iron in water sample by spectrophotometry
13. Estimation of copper in an alloy
14. Determination of percentage of nickel in an alloy
15. Evaluation of corrosion inhibition by weight loss method
16. Measurement of electrode potentials of metals/alloys

Text Books:

1. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Elias, A. J., A Collection of Interesting General Chemistry Experiments, Revised Edition, Universities Press, 2007

20CH2001	Complementary Chemistry	L	T	P	C
		3	**0**	**0**	**3**

Course Objectives:

Enable the student to

1. understand the basic concepts in chemistry
2. realize the importance of atomic structure and chemical bonding
3. learn the physical properties of liquids and colloids

Course Outcomes:

The student will be able to

1. realize the importance of acids and bases
2. summarize the importance of the atomic structure
3. understand the theories of chemical bonding
4. learn the physical properties of liquid
5. understand the basics of surface chemistry
6. recognize the importance of colloids in forensic science

Unit 1: Fundamental Concepts in Chemistry (9 Hours)

Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Concept of Equilibrium: Acids and Bases - Arrhenius, Lowry-Bronsted and Lewis theories. Ionic product of water - pH and pOH, Strengths of acids and bases - Ka and Kb, pKa and pKb. Electrode potential – Electrochemical series - Buffer solution. Preparation of buffer solution having a known pH. Solvation, solubility, solubility product, common ion effect and their applications.

Unit 2: Atomic Structure (9 Hours)

Bohrs's theory, atomic spectrum of hydrogen atom, Sommerfield's atomic models, de Broglie equation, Heisenberg's Uncertainty Principle and its significance, ScHoursödinger's wave equation. Quantum numbers, Atomic orbitals; shapes, radial and angular probability diagrams of s, p and d orbitals. Pauli's exclusion principle, Hund's rule, Aufbau principle and its limitations. Orbital energy with atomic number.

Unit 3. Chemical bonding (9 Hours)

Types - Ionic bonding - general characterization, types of ion, packing of ion in crystals, lattice energy. Covalent bonding – general characteristics, valence bond approach-, Hybridization – examples - MO Theory: Rules for the LCAO method,, nonbonding combination of orbitals, MO treatment of

homonuclear diatomic molecules and heteronuclear diatomic molecules such as CO and NO. Comparison of VB and MO approaches.valence shell electron pair repulsion (VSEPR) theory. Coordinate covalent bond, Hydrogen bond (theories of hydrogen bonding, valence bond treatment). Weak forces - Metallic bond.

Unit 4: Physical Properties of Liquids (9 Hours)

Physical Parameters of Liquid- Surface tension- Hydrostatic Pressure-Viscosity-Density- Vapor pressure- molar refraction-optical activity structure of liquid- Relative density-free volume of liquid and density measurement- Method of exploring concentration of solutions-binary liquids-vapor pressure-composite diagram of binary liquids and solutions- physical properties of blood

Unit 5: Surface Chemistry and Colloids (9 Hours)

Adsorption – Types – Langmuir and van der Waal's adsorption isotherm – Colloids – Types – preparation and properties – Surfactants – Micelles – Colloids and Forensic science – Application of Electrophoresis

References

1. R.K.Prasad, "Quantum Chemistry" –4th Edition, New Age International (2010)
2. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2007.
3. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint (2009).
4. CNR Rao, "University Chemistrty", Universities Press (1999)
5. Manas Chanda, "Atomic structure and chemical bonding". Tata Mc, Grawhill (2007)
6. Samir K Banerji, "Environmental Chemistry", Prentice – Hall of India PvtLts New Delhi (2007).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				2		
CO3	2			3			2		
CO4	2	1						3	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2002	Physical Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the fundamental principles and functions of crime lab services
2. learn various types of chemical analysis.
3. understand the working of the crime labs to fbi.

Course Outcomes:

The student will be able to

1. review the handling physical evidence
2. depict the data on different type of crime cases
3. write report on different type of analysis
4. examine the list of sample characterisation
5. compare and contrast the role of a crime lab services.
6. understand the chemistry of firearms

List of Experiments

1. Crime Lab Services – from local labs to the FBI -I
2. Handling Physical Evidence
3. Identification of evidence using microscopy – The example of hair analysis
4. Crime Lab Services – from local labs to the FBI -II
5. Chemistry and Firearms
6. Chemistry of Fingerprint Collection
7. Introduction to Sample Characterization Using Microscopy
8. Fingerprint Chemistry

9. Analysis of Glass Samples
10. Analysis of Pen Inks by TLC and Spectroscopic Methods
(Minimum 10 Experiments to be conducted)

Text books:

1. Skoog, D. A, West, D. M and Holler, F. J, "Fundamentals of Analytical Chemistry", 6th Edition, Saunders College Publishing, Fort Worth (1992).
2. W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire (1991).
3. J.W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York (1995).
4. D.R. Redsicker, The Practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton (2000).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		3	3	2
CO2	1	3						2	1	
CO3	1	2			3		2	2	2	2
CO4					1	3	1	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

'3'-High, '2'- Medium, '1'-Low, '-'No correlation

20CH2003	Inorganic Chemistry for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about periodic properties and nuclear chemistry
2. understand the chemistry of transition metals
3. learn the applications of various metals in Forensic Science

Course Outcomes:

The student will be able to

1. understand the periodic properties
2. learn the applications of radioisotopes
3. understand the nature of bonding in coordination complexes
4. predict the factors affecting the stability of metal complexes
5. summarize the importance of metals in biology
6. realize the role of metals in Forensic science

Unit 1: Periodic properties (9 Hours)

Periodic Properties: Modern periodic table – General characteristics of periods and groups –Periodicity in properties: Atomic radii, ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale)Diagonal relationships – General characteristics of s, p, d and f block elements: introduction, properties, and their position in periodic table.

Unit 2: Nuclear Chemistry and Radioactivity (9 Hours)

Nucleus – composition – Binding energy – Stability – Isotopes, Isobars and isotones – Radiation – characteristics of α, β and γ radiation – Nuclear reactions – Applications of radioisotopes – Radioactive tracers

Unit 3: Coordination Chemistry (9 Hours)

Ligands – Examples – Complex formation – Werner's theory – Sidgwick theory – Valence bond theory – Tetrahedral and octahedral complexes – Crystal field theory – CFSE –Factors affecting magnitude of 10Dq –Spectrochemical series – MO theory - stability – Factors affecting stability – Chelate and macrocyclic effect - Detection of complex formation

Unit4: Bioinorganic Chemistry (9 Hours)

Metal ions in biological systems – Biochemistry of iorn – Haemoglobin and Myoglobin, Mechanism of O2, CO2 transportation, Elementary idea of structure and mechanism of action of sodium potassium pump, Biochemistry of zinc and cobalt – Enzyme action – Examples

Unit 5: Metal complexes in Forensic science (9 Hours)

Heavy metal poisoning – Arsenic, Antimony, Barium, Copper, Iron, Lead, nercury, Thallium, Zinc – methyl mercury – detection - Schiff bases and their applications in forensic sciences – cupric arsenite

Text Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shrrver and Atkins, " Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A &Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. Madan W. H, Tuli G. D, Madan R. D., "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2004	Inorganic Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of volumetric titration and estimate the given unknown solution
2. understand the principles of chemical analysis
3. practice precise and accurate analysis

Course Outcomes:

The student will be able to

1. prepare standard solutions of known concentration
2. estimate different species in the unknown solution
3. identify qualitatively the inorganic salt
4. prepare inorganic metal complexes
5. estimate the given acid by instrumentation methods
6. enhance the analytical skill

LIST OF EXPERIMENTS

1. Preparing 0.01N H_2SO_4 standard solution and finding out the strength of $NaHCO_3$, in washing Soda
2. To determine the strength of oxalic acid solution by permanganometry.
3. To estimate dissolved oxygen in water sample
4. Qualitative Analysis of Inorganic salt I.
5. Qualitative Analysis of Inorganic salt mixture-II
6. Qualitative Analysis of Inorganic salt-III
7. Qualitative Analysis of Inorganic salt mixture-IV
8. To prepare metal complex -I
9. To Prepare metal complex- II
10. Estimation of Fe^{3+} by spectrophotometer
11. To determine the strength of acid by pH meter
12. To determine the strength of acid by conductometry

(Minimum 10 experiments to be conducted)

Text books:

1. Svehla G., "Vogel's Textbook of Qualititative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.

2. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		1			2		2		
CO2		2	3	1	2		3		
CO3		2			3		2	1	
CO4		1			2		1	2	
CO5		1			2	3	1	1	3
CO6		3	1	2			2		1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2005	Analytical Chemistry for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the procedure for handling chemicals and analysis
2. know the general purification techniques and titrimetric methods
3. learn the general separation techniques and thermoanalytical methods

Course Outcomes:

The student will be able to

1. know the methodology to handle chemicals, heating methods and error analysis
2. understand the principle of techniques used for the purification of compounds
3. know about importance of various titrimetric methods
4. get knowledge about solubility criteria, precipitation titrations and gravimetric analysis
5. receive the importance of thermogravimetric, differential thermal and electrogravimetry analysis
6. understand the basics of analytical chemistry for application in forensic science

Unit 1: Handling of Chemicals and Analysis (9 Hours)

Safety and hygiene in the Chemistry lab- Storage and handling of chemicals, handling of acids, ethers, toxic and poisonous chemicals, antidotes, threshold vapour concentration and first aid procedure – Heating methods, stirring methods, filtration techniques – Error in chemical analysis – Accuracy, precision, types of error-absolute and relative error, methods of eliminating or minimizing errors – Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation – Significant figures and its application with respect to the glassware used - Normal error curve and its importance.

Unit 2: General Purification Techniques (9 Hours)

Purification of solid organic compounds, recrystallisation, use of miscible solvents, use of drying agents and their properties, sublimation - Purification of liquids - Experimental techniques of distillation, fractional distillation, distillation under reduced pressure. Extraction, use of immiscible solvents, solvent extraction - Chemical methods of purification and test of purity.

Unit 3: Titrimetric Methods (9 Hours)

General principle - Types of titrations - Requirements for titrimetric analysis - Concentration systems: Molarity, formality, normality, wt%, ppm, milliequalence and millimoles-problems - Primary and secondary standards, criteria for primary standards – preparation of standard solutions, standardization of solutions - Limitation of volumetric analysis, endpoint and equivalence point - Acid-base equilibria - pH of strong and weak acid solutions - Buffer solutions - Henderson equations - Preparation of acidic and basic buffers. Relative strength of acids and bases from K_a and K_b values - Neutralisation-titration curve, theory of indicators, choice of indicators - Use of phenolphthalein and methyl orange - Complexometric titrations - Stability of complexes, titration involving EDTA - Metal ion indicators and characteristics - Problems based on titrimetric analysis.

Unit 4: Solubility Equilibria (9 Hours)

General separation techniques -Solubility and solubility products, expressions for solubility products - Determination of solubility from solubility products - Precipitation titrations -Argentometric titrations, indicators for precipitation titrations involving silver - Determination of chloride by Volhard's method - Adsorption indicators - Gravimetric methods of analysis - Separation by precipitation, factors affecting

solubility, gravimetric factor. Purity of precipitates, von Weiman ratio - Co-precipitation, post precipitation.

Unit 5: Thermoanalytical Methods (9 Hours)

Thermoanalytical methods - principle involved in thermogravimetric analysis and differential thermal analysis - characteristics of TGA and DTA - thermograms – factors affecting TGA and DTA curves - discussion of various components of the instrument with block diagrams - Applications of thermogravimetry - Applications of DTA - thermometric titration - Electrogravimetry - principle and applications.

Text Books:

1. D.A. Skoog, D.M. West and F.J. Holler, Analytical Chemistry: An Introduction, 5th edition, Saunders college publishing, Philadelphia, 1990.
2. U.N. Dash, Analytical Chemistry: Theory and Practice, Sultan Chand and sons Educational Publishers, New Delhi, 1995.
3. R.A. Day Jr. and A.L. Underwood, Quantitative Analysis, 5th edition, Prentice Hall of India Private Ltd., New Delhi, 1988.
4. R. Gopalan, Ps Subramanian and K. Rengarajan, Elements of Analytical Chemistry, S. Chand and Co., New Delhi, 2004.
5. Gurdeep R. *Chatwal* and Sham K. Anand, Instrumental Methods of Chemical Analysis, 5th edition, HimalaysPublishing House, 2018.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	2	1
CO2	-	1	1	1	1	1	1	2	3
CO3	-	1	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	-	1	1	1	1	1	1	2	3
CO6	1	1	1	1	1	1	1	2	3

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20CH2006	Organic Chemistry for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the chemical reactions, which are mostly used to synthesize compounds of various types, and their mechanism
2. distinguish the types of reactions and structure determination
3. understand the stereochemistry of compounds and biological molecules.

Course Outcomes:

The student will be able to

1. describe the basic principles of chemical structures and its bonding characteristics
2. predict the organic reaction mechanisms of organic reactions
3. understand the structures of heterocyclic compounds
4. describe the reaction intermediates
5. explain the principles of stereochemistry.
6. relate the applications of the biological molecules in various domains

Unit 1: Introduction to Electronic Effects (7 Hours)

Nature of bonds, Hybridisation in organic molecules, Homolysis and heterolysis of bonds, Electron displacement in organic compounds – Inductive, Electronic and Mesomeric effects- Influence of Inductive effect on acidic and basic properties of organic compounds. Hyperconjugation and steric effects

Unit 2: Reaction Intermediates and Heterocyclic Compounds (8 Hours)

Reaction intermediates-carbocation, free radicals and carbenes. Structure and stability of benzene-molecular orbital description- Aromaticity and Huckel's rule, Non benzenoid aromatic compounds, Heterocyclic compounds- structures of pyrrole, furan, pyran, thiophene, pyrazole, pyridine and pyrimidine.

Unit 3: Organic Reaction Mechanisms (10 Hours)

Nucleophilic substitution of alkyl halides: S_N1 and S_N2 mechanisms- walden inversion. Electrophilic addition to ethane and propene- Markownikoff's rule, free radical addition and peroxide effect. Elimination reactions- E1 and E2 mechanism- Mechanisms of dehydrohalogenation of alkyl halides, Aromatic Electrophilic substitution – mechanism of nitration, bromination, sulphonation and Fridel Crafts reactions- Aromatic nucleophilic substitution.

Unit 4: Stereochemistry (10 Hours)

Conformation and configuration, Rotation about carbon-carbon single bond, conformation of ethane, cyclohexane, methyl cyclohexane-explanation of more stable conformation. Geometrical isometrism: Explanation taking 2-butene, maleic and fumaric acid as examples. Optical isomerism- Optical activity, Chirality, racemisation and resolution (Lactic acid and tartaric acid examples).

Unit 5: Amino acids, Peptides and Proteins (10 Hours)

Amino acids – classification and properties, polypeptides and proteins – petide linkage, primary, secondary, tertiary and quaternary structure of proteins, test for proteins. Nucleic acids, structure of DNA and RNA differences, Functions, Different types of RNA, Genetic code, Self replication, mutation. Enzymes, characteristics, catalytic action, theory of enzyme catalysis Michaelismenten theory- Elementary treatment of the metabolism of carbohydrates, proteins and lipids

Text books

1. M.K. Jain, S.C. Sharma. Modern Organic Chemistry,Vishal Publishing Co.;, 2019.
2. BahlArun and Bahl B.S .Text book of Organic Chemistry, S Chand & Company, 2016.
3. I.L Finar,Organic chemistry – Vol I and II, Pearson Education India; 6th Edition, 2002.
4. Peter Sykes,A guide book to mechanism in organic chemistry. Pearson Education, 6th edition, 2003.
5. C.N. Pillai, Organic chemistry for undergraduates, Universities Press (India) Pvt Ltd. 2008
6. Tiwari, Mehrothra and Vishnoi, Text book for Organic Chemistry, 4th Edition,Vikas Publishing House Pvt. Ltd. New Delhi, 2017
7. Michael B. Smith, Jerry March, Advanced Organic Chemistry: Reactions, Mechanisms, and Structure John Wiley & Sons, Inc. 6th Edition, 18 May 2006

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3				1		3		
CO2	2	1			3		2	2	
CO3			2						
CO4				1	1		1		
CO5					3		2		
CO6	1		3	2		2		3	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2007	Instrumentation Techniques for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the concepts of absorption and emission spectroscopic techniques
2. know importance of electrochemical techniques in forensic investigation
3. learn about radio analytical techniques and sensors

Course Outcomes:

The student will be able to

1. know the importance of ir and nmr spectroscopy techniques and their application in forensic science
2. understand the forensic applications of uv and visible spectroscopic techniques
3. know the principle and instrumentation of fluorescence and phosphorescence spectrophotometry
4. understand the importance of electrochemical techniques in forensic science
5. understand the principle of radio analytical techniques
6. know the concepts and forensic applications of advanced techniques

Unit 1: Introduction to IR and NMR Spectroscopy (9 Hours)

Introduction – Properties of light, interaction of matter and light - Electromagnetic spectrum – Infrared (IR) spectroscopy, theory, instrumentation and and its application in forensic Science –Nuclear magnetic resonance (NMR) spectroscopy, theory, instrumentation and its application in forensic science.

Unit 2: Ultraviolet and Visible Spectroscopy (9 Hours)

Ultra violet (UV) and visible spectrophotometry – Types of sources and stability, wavelength selection, filters – cells and sampling devices, detectors, resolution, qualitative detection and quantitative measurements – Application in forensic science.

Unit 3: Fluorescence and Phosphorescence Spectrophotometry (9 Hours)

Fluorescence and phosphorescence spectrophotometry – Types of sources, structural factors, instrumentation – Applications in forensic science.

Unit 4: Electrochemical Methods (9 Hours)

Electrochemical techniques – Introduction – Principles, instrumentation, techniques and applications of potentiometry, coulometry, polarography and ion selective electrodes.

Unit 5: Radioanalytical techniques and sensors (9 Hours)

X-ray spectrometry - Electrophoresis – fundamental principles and forensic applications – Application of neutron activation analysis and isotope dilution methods – Introduction to sensors – Biosensors.

Text Books:

1. D.A. Skoog, D.M. West and F.J. Holler, Analytical Chemistry: An Introduction, 5th edition, Saunders college publishing, Philadelphia, 1990.
2. F.A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, 1997.
3. James W. Robinson, Atomic spectroscopy, 2nd Edition – Revised & Expanded, Marcel Dekkar, Inc., NY, 1996.
4. Gurdeep R Chatwal & Sham K. Anand, Instrumental methods of chemical analysis, Himalaya Publishing House, 2004.
5. S.H. James and J.J. Nordby, Forensic Science – An introduction to scientific and investigative techniques, CRC press, USA, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	1	1	2	1
CO2	1	1	1	2	1	1	1	2	1
CO3	1	2	1	2	1	1	1	2	1
CO4	1	1	1	2	1	1	1	2	3
CO5	1	1	1	2	1	1	1	1	2
CO6	1	1	1	2	1	3	1	2	1

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20CH2008	Analytical Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand experiments based on thin layer chromatography
2. learn colorimetric analysis
3. know crime scene photography and videography

Course Outcomes:

The student will be able to

1. experiment thin layer chromatography of ink samples
2. do the separation of organic compounds by paper chromatography
3. understand the crime scene exhibits by photography and videography
4. work out problems related tomean, media and standard deviation
5. know about data representation
6. know the applications of mass spectrometry in forensic science

LIST OF EXPERIMENTS

1. To carry out thin layer chromatography of ink samples
2. To determine the concentration of a colored compound by colorimetry analysis

3. To carry out separation of organic compounds by paper chromatography
4. To identify drug samples using UV – visible spectroscopy
5. To take photographs using different filters
6. To take photographs of crime scene exhibits at different angles.
7. To record videography of a crime scene
8. Work out the problems related to mean, median, mode, standard deviation, probability, Chi-square test, t-test and correlation
9. Familiarize the technique of data representation (tables, bar-diagram, histogram, pie- diagram and frequency curve (manual and using computer)
10. Applications of mass spectrometry in forensic science

(Minimum 10 Experiments to be conducted)

Text Books:

1. Frank Lundquist, MethodsofForensic Science, Vol. 1, New York, Interscience, 1962.
2. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
3. S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
4. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
5. Thomas Kubic and Nicholas Petraco, Forensic Science Laboratory Manual and Workbook, CRC Press, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	2	2	2
CO2	1	1	1	1	1	1	2	2	3
CO3	1	1	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	1	1	1	1	1	1	1	2	3
CO6	1	1	1	1	1	1	1	2	3

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20CH2009	Forensic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. get ideas on petroleum products.
2. learn the methods of searching and analyzing arson evidence etc
3. understand the classification of explosives and bomb scene management

Course Outcomes:

The student will be able to

1. understand the methods of analyzing trace amounts of petroleum products in crime scene evidence.
2. comprehend the method of searching, collecting, preserving and analyzing arson evidence.
3. deliver the process of post-fire analysis of materials.
4. realize the classification of explosives, including the synthesis and characterization of representative analogs.
5. apply the techniques of locating hidden explosives and
6. interpret the significance of bomb scene management.

Unit 1: Petroleum and Petroleum Products (9 Hours)

Distillation and fractionation of petroleum.Commercial uses of different petroleum fractions.Analysis of petroleum products.Analysis of traces of petroleum products in forensic exhibits.Comparison of petroleum products.Adulteration of petroleum products.

Unit 2: Cases Involving Arson (8 Hours)

Chemistry of fire.Conditions for fire.Fire scene patterns.Location of point of ignition.Recognition of type of fire.Searching the fire scene.Collection and preservation of arson evidence.

Unit 3: Post-fire Analysis of Materials (8 Hours)

Analysis of fire debris.Analysis of ignitable liquid residue.Post-flashover burning.Scientific investigation and evaluation of clue materials.Information from smoke staining.

Unit 4: Explosives (10 Hours)

Classification of explosives – low explosives and high explosives –Homemade explosives – Military explosives – Blasting agents - Synthesis and characteristics of TNT, PETN and RDX.

Unit 5: Explosion Process and Detection (10 Hours)

Explosion process. Blast waves. Bomb scene management.Searching the scene of explosion.Mechanism of explosion. Post blast residue collection and analysis. Blast injuries. Detection of hidden explosives.

Text Books:

1. S. Ballou, M. Houck, J.A. Siegel, C.A. Crouse, J.J. Lentini and S. Palenik in Forensic Science, D.H. Ubelaker (Ed.), Wiley-Blackwell, Chichester (2013).
2. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
3. J.D. DeHaan, Kirk's Fire Investigation, 3rd Edition, Prentice Hall, New Jersey (1991).
4. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, The Foundation Press, Inc., New York (1995).
5. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		2						1	
CO2	1			1	1	2	2		2
CO3	2	3	2						
CO4	2				2	3		1	1
CO5			2	1				1	2
CO6		2				1	1		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2010	Forensic Toxicology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. analyze trace amounts of petroleum products in crime scene evidence.
2. understand the methods of analyzing contaminants in petroleum products
3. classify and characterise of the narcotics, drugs and psychotropic substances.

Course Outcomes:

The students will be able to

1. know about chemistry of petroleum products forensic science.
2. understand the method of searching, collecting, preserving and analyzing arson evidence
3. know the techniques of locating hidden explosives.
4. know the narcotics, drugs and psychotropic substances forensic science
5. know the forensic identification of illicit liquors.
6. know about toxicology and poisons

Unit 1: Petroleum and Petroleum Products (9 Hours)

Introduction to Petroleum Products, Properties of Petroleum Products, Testing of Petroleum and Petroleum Products, Adulteration of petroleum products, Analysis of petroleum products as per BIS specifications. Analysis of Dyes used in petroleum products and forensic exhibits, Chemical fingerprinting of petroleum products.

Unit 2: Narcotics, Drugs and Psychotropic Substances (9 Hours)

Broad classification – Narcotics, stimulants, depressants and hallucinogens. General characteristics and common example of each classification. Natural, synthetic and semi-synthetic narcotics, drugs and psychotropic substances. Drug addicts and crimes, Tolerance, addiction and withdrawal symptoms of narcotics, drugs and psychotropic substances. Presumptive and screening tests for narcotics, drugs and psychotropic substances in breast milk, salvia, urine, hair and antemortem blood. Dope tests. Analysis of narcotics, drugs and psychotropic substances in postmortem blood. Postmortem changes affecting the

analysis of narcotics, drugs and psychotropic substances. Collection and preservation of drug evidence, excretion of drugs, Testing of narcotics, drugs and psychotropic substances- thin layer chromatography, gas – liquid chromatography and high performance liquid chromatography.

Unit 3: Alcoholic Beverages (Study and Analysis) (9 Hours)

Introduction, Definition of alcohol and illicit liquor, Alcoholic and non-alcoholic beverages and their composition, Proof spirit, absorption, de-toxication and excretions of alcohol, problems in alcohol cases and difficulties in diagnosis, Alcohol and prohibition, Consequences of drunken driving, Estimation of ethyl alcohol in blood and urine, Analytical techniques in the analysis of alcohol and other articles, Crime scene management in illicit liquor cases.

Unit 4: Fire & Arson: (9 Hours)

Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron, Conditions for fire, Backdraft, Thermo-chemistry of Fire, Heat Capacity and Phase changes, Accelerants & types of accelerants, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapour density, vapour pressure, Fire extinguisher. Arson: Legal Definition, Arson motives, Degrees of Arson, Forensic and legal Concepts, Determining origin and cause; Fire patterns, Collection/Preservation of Arson Evidences, Flashover, Live or dead at time of arson; Documenting the fire or crime scene; Scheme of analysis: Extraction of samples from debris (Direct and solvent extraction methods, Head Space method, SPME, Distillation), Clean-up (Filtration & Acid stripping), Analysis (GC, GC-MS, FTIR & SEM etc.), Interpretation of GC-MS spectra., Scientific investigation and evaluation of clue materials

Unit 5: Basics of Toxicology and Poisons(9 Hours)

Classification of poisons-Plant Poison, Animal Poison, Metallic Poison,Physico-chemical characteristics and mode of action of poisons. Accidental, suicidal and homicidal poisonings. signs and symptoms of poisoning, mode of action and its effect on vital functions, medico-legal and post mortem examination report/finding studies, specific analysis plan/ approach to toxicological examination of poisoning samples, excretion of poisons, detection of poisons on the basis of their metabolic studies, interpretation of analytical data Animal poisons. Snake venom. Mode of action. Carbon monoxide poisoning. Significance of toxicological findings. Techniques used in toxicology. Toxicological analysis and chemical intoxication tests. Postmortem Toxicology. Human performance toxicology. Dose-response relationship.

Text books:

1. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition. The Foundation Press, Inc., New York (1995)
2. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004)
3. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's , Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
4. F.G. Hofmann, A Handbook on Drug and Alcohol abuse, 2nd Edition, Oxford University Press, New York (1983)
5. S.B. Karch, The Pathology of Drug Abuse, CRC Press, Boca Raton (1996). 6. A. Poklis, Forensic toxicology in, Introduction of Forensic Sciences, 2nd Edition.
6. Laboratory procedure Manual, Forensic Toxicology: DFS, 2005
7. Levine Barry, Principles of Forensic Toxicology, 2nd Edn., (2006)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					2		
CO2	3		2				3		
CO3	2			3			2		
CO4	3	1						2	
CO5	3				2		3		
CO6	2			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2011	Forensic Toxicology Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand the methods of analyzing trace amounts of petroleum products in crime scene evidence.
2. learn the methods of analyzing contaminants in petroleum products
3. classify and characterize of the narcotics, drugs and psychotropic substances.

Course Outcomes:

The students will be able to

1. know about chemistry of petroleum products forensic science.
2. know the method of searching, collecting, preserving and analyzing arson evidence
3. know the techniques of locating hidden explosives.
4. know the narcotics, drugs and psychotropic substances forensic science
5. know the forensic identification of illicit liquors.
6. know about toxicology and poisons

LIST OF EXPERIMENTS

1. To identify biocides.
2. To identify metallic poisons.
3. To identify organic poisons.
4. To identify ethyl alcohol.
5. To identify methyl alcohol.
6. To carry out quantitative estimation of ethyl alcohol.
7. To prepare iodoform.
8. To identify drugs of abuse by spot tests.
9. To perform color tests for barbiturates.
10. To separate drugs of abuse by thin layer chromatography.

(Minimum 10 Experiments to be conducted)

Text books:

1. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
2. F.G. Hofmann, A Handbook on Drug and Alcohol Abuse, 2nd Edition, Oxford University Press, New York (1983).
3. S.B. Karch, The Pathology of Drug Abuse, CRC Press, Boca Raton (1996).
4. A. Poklis, Forensic toxicology in, Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
5. A.W. Jones, Enforcement of drink-driving laws by use of per se legal alcohol limits: Blood and/or breath concentration as evidence of impairment, Alcohol, Drug and Driving, **4**, 99 (1988).
6. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		2	3	1
CO2	1	3						1	1	
CO3	1	2			3		2	2	2	2
CO4		2			1	3	2	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

'3'-High, '2'- Medium, '1'-Low, '-'No correlation

20CH2012	Crime Investigation Techniques	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the importance of chromatographic techniques in processing crime scene evidence.
2. learn the utility of surface characterization techniques
3. learn the significance of microscopy in visualizing trace evidence and comparing it with control samples.

Course Outcomes:

The student will be able to

1. know principle of chromatographic techniques.
2. know applications of chromatographic techniques.
3. understand the principles of X-ray diffraction techniques
4. realize the importance of Electron microscopy
5. understand the applications of electron microscopic techniques
6. understand advance photographic methods for forensic science

Unit 1: Chromatography-I

Liquid Chromatography Introduction, History, Classification, Principle & basic theory of chromatography, Column adsorption chromatography, Partition chromatography, Band broadening & column efficiency, Factors affecting, Plate theory & Rate theory of chromatography, Types of Liquid chromatography, Theory, principle and Instrumentation of HPLC, Types of column, Column efficiency, Pumps, Various types of detector, Injection system, Isocratic and gradient elution, Normal phase and Reverse phase liquid chromatography, Development of HPLC and UPLC method, Choice of stationary and mobile phase, Difference between HPLC and UPLC, Applications.

Unit 2: Chromatography II

Thin Layer Chromatography Introduction, Theory, Principle and Instrumentation of TLC, Method for the preparation of thin layers on plates, Application of sample on the chromo plates, Choice of adsorbent, Choice of mobile phase, Detecting reagent, Developing chamber, Developing and detection, Ascending, Descending and two dimensional TLC development, Impurity profiling with the help of TLC, Applications.Sample preparation for chromatographic and spectroscopic evidence.Chromatographicmethods.Fundamental principles and forensic applications of thin layer chromatography, gas chromatography and liquid chromatography.

Unit 3: X-Ray Diffraction Techniques

Properties of X-rays -crystallography, geometry of crystals, diffraction and experimental methods like powder XRD and applications like crystal size, crystal structure, amorphous materials, precise parameter measurements, phase diagram determination and multiphase quantitative analysis. Introduction to X-ray diffraction. Electron diffraction Neutron diffraction About crystal structures and diffraction patterns. Practical aspects of electron diffraction Instrumental details and analysis of XRD pattern. Residual stress measurements.

Unit 4: Microscopy SEM, TEM

Introduction to materials and methods, Fundamentals of Materials Characterization, Basic operation, sample preparation and interpretation of data. Basic failure analysis of materials using different characterization equipment. Introduction to Scanning electron microscopy, Instrumental details and image formation,. Various imaging techniques and spectroscopy Sample preparation and Applications-Introduction to Transmission electron microscopy (TEM) Science of Imaging and diffraction TEM instrumental details and variants in imaging techniques. Sample preparation procedures and instruments for various materials, Fundamental principles. Different types of microscopes. Electron microscope.ComparisonMicroscope.Forensic applications of microscopy.

Unit 5: Forensic photography

Basic principles and applications of photography in forensic science.3D photography Photographic evidence.Infrared and ultraviolet photography. Digital photography-Crime scene and laboratory photography

Text books:

1. D.A. Skoog, D.M. West and F.J. Holler, Fundamentals of Analytical Chemistry, 6th Edition, Saunders College Publishing, Fort Worth (1992).
2. W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire (1991).
3. J.W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York (1995).
4. D.R. Redsicker, The Practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton (2000).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		

CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2013	Nanochemistry in Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about nanomaterials
2. understand about the synthesis of nanomaterials
3. learn the use of nanomaterials in Forensic Science

Course Outcomes:

The student will be able to

1. know the evolution of nanotechnology
2. understand the classification of nanomaterials
3. understand the various types of synthesis of nanomaterials
4. characterize the nanomaterials
5. know the applications of nanomaterials
6. understand the application of nanomaterials in forensic science

Unit 1: Basics of Nanotchnology (9 Hours)

Historical landmarks - terminology-scales. Classification of nanomaterials based on dimension - Top-down and bottom-up approaches - Comparison. – Challenges in nanotechnology - Top down methods – Core shell nanomaterials – Toxic effect of nanomaterials- Existing laws and regulations of nanotechnology- regulatory agencies- - green nanotechnology- nanoethics - future of nanotechnology.

Unit 2: Synthesis of Nanomaterials (9 Hours)

Synthesis of metallic, semiconductor and oxide nanoparticles – sol-gel- method – Synthesis by reduction - One dimensional nanoparticles – nanowires and nanorods – VLS method – electrospinning – Lithography – Two dimensional nanomaterials – PVD – Molecular beam epitaxy - CVD - Self Assembly

Unit 3: Special Nanomaterials and Methods: (9 Hours)

Fullerenes – types - carbon nanotubes – types - Micro and mesoporous nanomaterials – Soft lithography - Dip pen nanolithography

Unit 4: Applications of Nanotechnology-I (9 Hours)

Applications of nanotechnology in various fields – Electronics, Catalysis a nd Biology - Nanobiology and its applications- Nanomedicines- immuno targeted drug delivery-- nanoparticle drug systems for oral, nasal, and ocular administration- nanomaterials in medical diagnosis - therapeutic applications. Nanosensors- smart dusts.

Unit 5: Applications of Nanotechnology-II (9 Hours)

utilization of nanotechnology in analysis of physical evidences, selectivity of nanoparticles with compatibility and feasibility, Application of nanotechnology in forensic evidence analysis- Forensic Applications: Collection and analysis of evidence of different types of crime scenes including drugs, DNA analysis, blood splattering, serology, toxicology

References

1. Guozhong Cao,Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial press, 2004
2. Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi (2007).
3. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009.
4. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005). 4. J. M. M. Duart, R. J. M. Palma and F.A. Rueda,Nanotechnology and Microelectronics and optoelectronics, Elsevier (2002).
5. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008.

6. K. J. Klabunde, Nanoscale materials in chemistry, John Wiley and Sons.
7. C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley IndiaPvt Ltd 2009.
8. L. E. Foster, Nanotechnology: Science, Innovation and Opportunity, Pearson Education (2008).
9. The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II, CNR Rao, Springer (2006).
10. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2001	Fundamentals of Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about the fundamental principles and functions of forensic science
2. understand the significance of forensic science to human society
3. know the working of the forensic establishments in india

Course Outcomes:

The student will be able to

1. point out the importance of forensic sciences
2. understand the techniques involved in forensic sciences
3. know various laboratories available to serve forensic science
4. understand the importance of police organization
5. describe the crime and filing a crime
6. investigate the crime scene

Unit 1: Development and Tools and Techniques in Forensic Science (10 Hours):

History, scope, functions and need of forensic science – definitions and concepts in forensic science. basic principles -branches of forensic science. Frye case and Daubert standard - Forensic science in international perspectives – Forensic scientists – duties, code of conduct and qualifications

Unit 2: Organizational set up of Forensic Science Laboratories in India (9 Hours)

Hierarchical set up of Central Forensic Science Laboratories, State Forensic Science Laboratories, Fingerprint Bureaus, National Crime Records Bureau, Police & Detective Training Schools, Bureau of Police Research & Development, Directorate of Forensic Science and Mobile Crime Laboratories. Police Academies -Services of crime laboratories. Basic services and optional services - Drug enforcement administrator. Defense research and development organization.

Unit 3: Police Organization (8 Hours)

Organizational set up of Police at central and state level, Functions of Police, Relationship of Police and Forensic Scientist, History of different para-military forces (BSF, CISF, CRPF, ITBP, Assam Rifles, SSB, NSG etc.)

Unit 4: Legal aspects of crime(9 Hours)

Crime – Introduction,definition, types, causes and consequences - Broad concepts of criminal Justice system, Procedures involved in the detection of crime, Filing of criminal charges, Indian police system – The Police Act, Human rights and criminal justice system in India. Set up of INTERPOL.

Unit 5: Crime Scene (9 Hours)

Introduction, Significance, Role of Investigator, Evaluation of crime scene, protection of crime scene, Photography of Crime scene, Tools and techniques, Significance of Photography and Videography, Introduction of Sketching, Purpose of Sketching, Making of Sketches, Types of Sketches, Methods of

Sketching, Procedure of Sketching, Searching Methods, Chain of Custody types, Significance and their evaluation

Text Books:

1. B.B. Nanda and R.K Tiwari, "Forensic Science in India: A vision for the Twenty First Century", select publishers, New Delhi, 2001.
2. V. N. Sehgal, Surinder Nath and M. K. Bhasin, "Studies in Forensic Science No. 3: Society, Crime and Prosecution", Kamla-Raj Enterprises, New Delhi, 2005.
3. S.H James and J.J Nordby, "Forensic Science:An introduction to scientific and Investigative Techniques", 2nd Edition, CRC Press, Boca Raton, 2005.
4. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED), CRC Press, Boca Raton, 1997.
5. B. A. J. Fisher, D. R. Fisher,"Techniques of Crime Scene Investigation", CRC Press, 8th Edition, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		3	1		1	2		1
CO2	2	2					2	3	
CO3		3	2	2	1		2	3	
CO4				3		1			2
CO5			2	3		1	3		
CO6	2		3	3		1	3	2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2002	Crime and Society	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the concepts and approaches of crime
2. Know the major form of crime in India and changing profile of crime
3. Learn the theories of punishment and prevention of crime

Course Outcomes:

The student will be able to

1. Know the recent trends in criminology, changing profile of crime and criminals
2. Understand the forms and recent trends in crime
3. Learn the theories of Punishment and Prevention of crime
4. Take up the professional roles of correctional agents in agencies of criminal justice administration
5. Understand the social and governmental regulations with regard to crime
6. Understand about Indian judicial system

Unit 1: Concepts of crime and approaches to crime (9 Hours)

Crime: Nature and definition - Characteristics of crime in modern society - Causes of crime (social, economic, political and cultural) - Approaches to Crime - A Functionalist perspective: Emile Durkheim (Crime as inevitable), Robert Merton (Social structure and anomie) - An Interactionist perspective: Howard Becker (Labelling theory) - Marxist perspective: William Chambliss (Capitalism and crime), Laureen Snider (Corporate crime), David Gorden (Selective law enforcement) - Neo-Marxist [perspective: Ian Taylor, Paul Walten, Jock Young (The new criminology).

Unit 2: Major forms of crime in India and changing profile of crime (9 Hours)

Crime against SCs, STs and DTNTs: Meaning and corms - Crime against Women: Meaning, forms and causes. (Sex selective abortions, domestic violence, dowry deaths, sexual abuse, sexual harassment at work place, rape, violence, trafficking etc.) - Juvenile delinquency and crime against children: Meaning and causes - White collar crime: Meaning and features - Organised crime: Meaning and features - Terrorism: Concept, features and causes - Custodial crime: Meaning and features.

Unit 3- New forms of crime and recent trends in crime (9 Hours)

Corporate crime - Human rights violation - Cyber crime - Criminalization of politics - Environmental crimes - International crimes.

Unit 4: Theories of Punishment and Prevention of crime (9 Hours)

Deterrent Theory - Preventive theory - Reformative theory - Punishment, prison and alternative imprisonment (open prison, probation, parole) - Rehabilitation of prisoners - Human right perspective - Crime and the role of media.

Unit 5: An introduction to IPC (Indian Penal Code) and Judiciary (9 Hours)

An outline of Indian Penal Code (IPC) – Offences related to marriage – Offences related to religion – Judiciary – Criminal Procedure Code – Outline – Role of police – Indian judicial system.

Text Books:

1. Ahuja Ram, Criminology, Rawat Publishers & Distributors, Jaipur, 2000
2. Ahuja Ram, Social Problems in India, Rawat Publications, Delhi and Jaipur, 1997.
3. Bhosale, Smriti. Female Crime in India, KalpazPublications, New Delhi, 2009.
4. Gill, S.S., The Pathology of Corruption, Harper Collins Publishers, New Delhi, 1998.
5. Russel, William, Crime: Vol. I & II, Stevens and sons, London, 1964.
6. Tapas K. Banarjee, Background to Indian Criminal Law, Cambray, Kolkata, 1963.
7. Goel, Rakesh and Manohar Powat. Computer Crime: Concept,Control and Prevention. Saymson Computers Pvt.Ltd., Bombay, 1994.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	1	2	2	1	2	2
CO3	1	-	1	1	1	1	1	-	1
CO4	1	1	1	1	1	1	2	2	3
CO5	1	1	1	1	1	1	2	1	3
CO6	1	1	1	1	1	1	1	-	1

"3"– High; "2"– Medium; "1"– - Low; "-"– No correlation

20FS2003	Forensic Physics	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. understand the physics of speech which is important in speaker identification,
2. describe the causes and investigation of vehicular accidents, and its legal implications.
3. explain the parts of a camera, different types of photography and importance of forensic photography used in the investigation of crime.

Course Outcomes

The students will be able to:

1. understand the physics of sound production
2. apply phonetics and voice analysis in Forensic Science,
3. understand the causes and investigations done in vehicular accidents
4. explain the legal provisions about forensic photography
5. Interpret the various methods of photographing a crime scene etc.
6. describe the various tool marks

Unit 1:Forensic Speaker identification (9 Hours)

Human Vocal cord anatomy, Voice Production, Speaker identification and authentication, Forensic phonetics, Voice analysis, Forensic Significance

Unit 2: Automobile Accidents- Causes and Investigation (9 Hours)

Vehicular accidents-Introduction, Information sources: eye witnesses, Tire and other mark, Pedestrian impacts and vehicle speed, vehicle condition, vehicle damage, curved scuffmarks, Time and distance, reaction time, Vehicular Accident Photography

Unit 3: Automobile Accidents- Legal Aspects (7 Hours)

Relevant Provisions of Motor Vehicle Act, 1988 (Offenses and Penalties); Relevant Provisions of Indian Penal Code, 1860, (Sections 337 (causing hurt), 304 A (causing death due to negligence) and 279 (rash and negligent driving)

Unit 4: Forensic Photography (10 Hours)

Introduction, 35 mm film Camera, Digital SLR camera, Digital photo imaging, ISO number, Exposure Index, Photo imaging evidence: angle, scale, depth of field, light, ambient light, colour, temperature,

flash/ strobe; Surveillance photography and Aerial photography and accessories used for the same; Various methods for developing photographs; High-speed photography; Image magnification, U. V. and I. R. illumination, legal aspects of visual evidence

Unit 5: Introduction to Tool Marks (10 Hours)

Definition, types of tool marks: compression marks, striated marks, combination of compression and striated marks, repeated marks: class characteristics and individual characteristics, tracing and lifting of marks, Photographic examination of tool marks; Restoration of Erased / Obliterated Marks: methods of making-cast, punch, engrave; methods of obliteration, methods of restoration- etching (etchings for different metals), magnetic, electrolytic etc., recording of restored marks.

Text Books

1. Encyclopedia of Forensic Science, Volume 1-3: Jay A Siegel, Pekka J Saukko, GeofferyKnupfer. Academic Press. 2nd Edition, 22February 2013.
2. Criminalistics: An Introduction to Forensic Science: Richard Saferstein, Pearson Education International, 12th Edition, 3 January 2017.
3. Redsicker, D. R., The Practical methodology of Forensic Photography, CRC Presss, London, 2ndEdition, 26 September 2000.
4. Stuart H. James and Jon J. Nord,Forensic Science: An Introduction to Scientific and Investigative Techniques,CRC Press, 4th Edition, 13 January 2014.
5. Edward M Robinson, Crime Scene Photography, Academic Press, 3rd Edition, 15August 2016.
6. Tom Ang, Digital Photography, reprint, 2013.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1							1
CO2	3	1		3					2
CO3	1		3	3	1	1	3	3	1
CO4			2	2	2	1	3	3	
CO5	1		1		3	2	2	2	
CO6		2		1			1	2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2004	Fundamentals of Forensic Science Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the fundamental principles and functions of forensic science.
2. know the divisions in a forensic science laboratory.
3. know the working of the forensic establishments in india and abroad.

Course Outcomes:

The students will be able to

1. review the sections in forensic science
2. depict the data on different type of crime cases
3. write report on different type of crime cases
4. examine the list of projects undertaken by the bureau of police research and development.
5. compare and contrast the role of a police academy.
6. compare the code of conduct prescribed by forensic scientists.

LIST OF EXPERIMENTS

1. To study the history of crime cases from forensic science perspective.
2. To cite examples of crime cases in which apprehensions arose because of Daubert standards.
3. To review the sections of forensic science at INTERPOL and compare with those in Central Forensic Science Laboratories in India. Include suggestions for improvements if any.
4. To study the annual reports of National Crime Records Bureau and depict the data on different type of crime cases by way of smart art/templates.
5. To write report on different type of crime cases.
6. To review how the Central Fingerprint Bureau, New Delhi, coordinates the working of State Fingerprint Bureaus.

7. To examine the hierarchical set up of different forensic science establishments and suggest improvements.
8. To examine the list of projects undertaken by the Bureau of Police Research and Development and suggest the thrsust areas of research in Police Science.
9. To compare and contrast the role of a Police Academy and a Police Training School.
10. To compare the code of conduct prescribed by different establishments for forensic scientists.

(Minimum 10 Experiments to be conducted)

Text Books:

1. M. Houck, Jay Siegel, "Fundamentals of Forensic Science", Academic Press, 3rd Edition, 2015.
2. T. Kubic, N. Petraco, "Forensic Science Laboratory Manual and Workbook", CRC Press, 3rd Edition, 2009.
3. K. Mirakovits, G. Londino-Smolar,"The Basics of Investigating Forensic Science"CRC Press; 1stedition, 2015.
4. V. N. Sehgal, Surinder Nath and M. K. Bhasin, "Studies in Forensic Science No. 3: Society, Crime and Prosecution", Kamla-Raj Enterprises, New Delhi, 2005.
5. S.H James and J.J Nord, "Forensic Science: An introduction to scientific and Investigative Techniques", 2nd Edition, CRC Press, Boca Raton, 2005.
6. B. A. J. Fisher, D. R. Fisher, "Techniques of Crime Scene Investigation", CRC Press, 8th Edition, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	1			2		1
CO2	2	2			1		3	3	
CO3			2	3					2
CO4	3	2			2	1	2		
CO5	1		1	3		1	1		3
CO6	2			3	2	2	2		3

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2005	Indian Constitution, Fundamental Laws and Procedure	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. learnelements of criminal procedure code related to forensic science.
2. learnacts and provisions of the constitution of india related to forensic science.
3. learnacts governing socio-economic crimes.

Course Outcomes:

The students will be able to

1. understand various types of crime laws
2. understand section laws
3. understand witnessrelated laws
4. know the principles and basics of indian constitution
5. recognize social crimes
6. recognize environmental crimes

Unit 1: Law to Combat Crime (12 Hours)

Classification – civil, criminal cases. Essential elements of criminal law.Constitution and hierarchy of criminal courts.Criminal Procedure Code.Cognizable and non-cognizable offences.Bailable and non-bailableoffences.Sentences which the court of Chief Judicial Magistrate may pass.Summary trials – Section 260(2).Judgements in abridged forms – Section 355.

Unit 2: Section Laws (12 Hours)

Indian Penal Code pertaining to offences against persons – Sections 121A, 299, 300, 302, 304A, 304B, 307, 309, 319, 320, 324, 326, 351, 354, 359, 362. Sections 375 & 377 and their amendments.Indian Penal Code pertaining to offences against property Sections – 378, 383, 390, 391, 405, 415, 420, 441, 463, 489A, 497, 499, 503, 511.

Unit 3: Evidence & Witness Laws (12 Hours)

Indian Evidence Act – Evidence and rules of relevancy in brief. Expert witness. Cross examination and re-examination of witnesses. Sections 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, 138, 141.Section 293 in the code of criminal procedure.

Unit 4: Constitution of India (12 Hours)

Preamble, Fundamental Rights, Directive Principles of State Policy. – Articles 14, 15, 20, 21, 22, 51A.

Unit 5: Acts Pertaining to Socio-economic and Environmental Crimes (12 Hours)

Narcotic, Drugs and Psychotropic Substances Act.Essential Commodity Act.Drugs and Cosmetics Act.Explosive Substances Act. Arms Act. Dowry Prohibition Act.Prevention of Food Adulteration Act.Prevention of Corruption Act.Wildlife Protection Act. I.T. Act. Environment Protection Act.Untouchability Offences Act

References:

1. D.A Bronstein, Law for the Expert witness, CRC press, Boca Raton (1999)
2. Vipa P. Sarthi, Law of Evidence, 6th Edition, Eastern Book Co. Lucknow (2006)
3. A.S. Pillia, Criminal Law, 6th Edition, N.M. TripathiPvt Ltd, Mumbai (1983)
4. R.C Nigam, Law of crimes in India, Volume I, Asia Publishing House, New Delhi, (1965)
5. (Chief Justice) M.Minor, Law of Evidence, 6th Edition, Universal Law of Publishing Co.Pvt. Ltd. New Delhi(2002)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	2		2				2		
CO3	3		2	3			3		
CO4	2	1						2	
CO5	3				2		3		
CO6	3			1					3

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2006	Forensic Dermatoglyphics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student

1. learn types and importance of fingerprinting
2. understand the methods to develop the fingerprints
3. learn about other types impressions in the crime scene region

Course Outcomes:

The student will be able to

1. understand the fundamental principles on which the science of fingerprinting is based.
2. learn the importance of fingerprints
3. learn the methods of recording fingerprints
4. summarize the methods of classifying criminal records by fingerprints
5. understand the ways of physical and chemical techniques of developing fingerprints on crime scene evidence.
6. The significance of foot, palm, ear and lip prints

Unit 1: Basics of fingerprinting (8 Hours)

Introduction and history, with special reference to India. Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting. Types of fingerprints. Fingerprint patterns. Fingerprint characters. Plain and rolled fingerprints. Classification

Unit 2: **Record of fingerprinting (8 Hours)**

method for fingerprint record keeping. Automated Fingerprint Identification System. Classification and cataloguing of fingerprint record. Automated Fingerprint Identification System. Significance of poroscopy and edgeoscopy.

Unit 3: Development of Fingerprints-I (8 Hours)

Latent prints. Constituents of sweat residue.Latent fingerprints' detection by physical and chemical techniques.Mechanism of detection of fingerprints by different developing reagents.

Unit 4: Development of fingerprints-II (9 Hours)

Application of light sources in fingerprint detection. Preservation of developed fingerprints. Digital imaging for fingerprint enhancement. Fingerprinting the deceased. Developing fingerprints on gloves.

Unit 5:Foot prints Other impressions (12 Hours)

Importance of footprints. Casting of foot prints, Electrostatic lifting of latent foot prints. Palm prints - Lip prints – Nature, location, collection and examination of lip prints. Ear prints and their significance. Palm prints and their historical importance.

Text Books:

1. J.E. Cowger, Friction Ridge Skin, CRC Press, Boca Raton (1983).
2. D.A. Ashbaugh, Quantitative-Qualitative Friction Ridge Analysis, CRC Press, Boca Raton (2000).
3. C. Champod, C. Lennard, P. Margot an M. Stoilovic, Fingerprints and other Ridge Skin Impressions, CRC Press, Boca Raton (2004).
4. Lee and Gaensleen's, Advances in Fingerprint Technology, 3rd Edition, R.S. Ramotowski (Ed.), CRC Press, Boca Raton (2013).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		2	3	2		3		
CO2	3	2	1				1	3	
CO3	2	3			1		2	3	
CO4	3	3		3	2		3	3	2
CO5	2	3			1		2	3	
CO6	3	3	1		2	1	2	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2007	Forensic Science Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn about evaluation of crime scene
2. classify poisons and their modes of actions
3. know the forensic significance of dna typing

Course Outcomes:

The students will be able to

1. evaluate of crime scene
2. correlate the nature of injuries
3. examine poisons and their modes of actions
4. determine whether the crime was staged to appear as suicide or accident.
5. carry out analysis of explosive substances
6. write report on the role of forensic significance of dna typing

LIST OF EXPERIMENTS

1. To prepare a report on evaluation of crime scene
2. To prepare a case report on a case involving arson
3. To correlate the nature of injuries with distance from which the bullet was fired.
4. To identify metallic poisons
5. To identify organic poisons
6. To carry out analysis of explosive substances.
7. To prepare a case report on bomb scene management.
8. To design a checklist for the forensic scientists at the death scene
9. To carry out the separation of amino acids by thin layer chromatography
10. To prepare a report on the role of DNA typing in solving paternity disputes.

(Minimum 10 Experiments to be conducted)

Text Books:

1. M. Houck, Jay Siegel, "Fundamentals of Forensic Science", Academic Press, 3rd Edition, 2015.

2. T. Kubic, N. Petraco, "Forensic Science Laboratory Manual and Workbook", CRC Press, 3rd Edition, 2009.
3. K. Mirakovits, G. Londino-Smolar,"The Basics of Investigating Forensic Science"CRC Press; 1stedition, 2015.
4. V. N. Sehgal, Surinder Nath and M. K. Bhasin, "Studies in Forensic Science No. 3: Society, Crime and Prosecution", Kamla-Raj Enterprises, New Delhi, 2005.
5. S.H James and J.J Nord, "Forensic Science: An introduction to scientific and Investigative Techniques", 2nd Edition, CRC Press, Boca Raton, 2005.
6. B. A. J. Fisher, D. R. Fisher, "Techniques of Crime Scene Investigation", CRC Press, 8th Edition, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		2	3	2		3		
CO2	3	2	1				1	3	
CO3	2	3			1		2	3	
CO4	3	3		3	2		3	3	2
CO5	2	3			1		2	3	
CO6	3	3	1		2	1	2	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2008	Forensic Science &Criminal Justice System	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student

1. understand basic principles of forensic science
2. know the scene of crime, physical evidence and collection of biological stains
3. learn the theories of causation of crime, indian penal code and criminal justice system.

Course Outcomes:

The student will be able to

1. know the development of forensic science
2. understand the types, protection of scene of crime and preservation of scene of crime
3. understand the theories of causation of crime and forms of punishment
4. understand the importance of criminal procedure code and indian evidence act
5. know the operation of criminal justice systems and related procedures
6. understand about report formats of crime scene and laboratory findings

Unit 1: Crime (9 Hours)

Crime: Definition, theories of causation of crime - Pre–classical and Neoclassical, constitutional, geographical, economic, physiological, sociologist, Multiple causation approach - General factors of crime, forms of punishment in brief.

Unit 2: Scene of crime (9 Hours)

Scene of crime - Types, protection of scene of crime, preservation (recording) of scene of crime-photography and sketching methods - Physical evidence: Meaning, types, search methods, collection and preservation – Forwarding - Chain of custody - Collection, preservation, packing and forwarding of: blood, semen and other biological stains, firearm exhibits, documents, fingerprint, viscera, hair &fibre, glass, soil and dust, petroleum products and drugs and poisons.

Unit 3: Criminal Justice system - I(9 Hours)

Introduction to constitution of India – Administration of civil and criminal justice – Hierarchy of courts – Powers of courts – Types of courts – Lok Ayukta system - Organization of courts in India, jurisdiction of courts in criminal cases - Human rights and criminal justice system in India - prosecution

Unit 4: Criminal Justice System - II (9 Hours)

Broad components of criminal justice system. The structure of Police organizations in India – Functions and duties of police Policing styles and principles. Police's power of investigation. Filing of criminal charges. Community policing. Policing a heterogeneous society. Correctional measures and rehabilitation of offenders. F.I.R., case diary, roznamacha - Report Writing and Evidence Evaluation - Report formats of crime scene and laboratory findings.

Unit 5: Indian Penal Code (9 Hours)

Indian Penal Code: Introduction, General exceptions, offences against person - Offences against property - Attempt to suicide - sexual offences - Criminal procedure code - Introduction and general ideal of sections: 291-93, 154, 155, 156, 157, 158, 159, 160, 161, 162, 172, 173, 174, 175, and 176 - Indian Evidence Act : Introduction and general ideal of sections : 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, and 159.

Text Books:

1. Saferstein, Criminalistics - An introduction to Forensic Science, Prentice hall Inc., USA, 1995.
2. C.G.G. Aitken and D.A. Stoney, The use of statistics in Forensic Science, Ellis Harwood Limited, England, 1991.
3. James, S.H. and Nordby, J.J., Forensic Science; an introduction to Scientific and Investigative Techniques, CRC Press, USA, 2003.
4. Jon J. Nordby, Dead Reckoning: The Art of Forensic Detection, CRC Press LLC, Boca Raton FL, CRC Press, 2000.
5. Schmalleges Frank, Criminal Justice Today, Prentice Hall, New Jersey, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	-	1	1	1	1	1	1	2
CO2	1	1	1	1	1	1	1	2	2
CO3	1	-	1	1	1	1	1	2	1
CO4	1	1	1	1	1	1	1	1	3
CO5	1	1	1	1	1	1	1	1	1
CO6	1	1	1	1	1	1	1	2	3

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20FS2009	Forensic Physics Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand the analysis of soil, paint and glass samples
2. know about tool marks
3. understand about microscopic examination of different samples

Course Outcomes:

The student will be able to

1. do density gradient method
2. experiment paint samples by physical matching and thin layer chromatography methods
3. know about spectrochemical analysis of samples
4. examine and authenticate audio and video recordings
5. know about storage media and its authentication
6. know about the methodology to collect digital evidences

LIST OF EXPERIMENTS

1. To compare soil samples by density gradient method
2. To compare paint samples by physical matching method
3. To compare paint samples by thin layer chromatography method
4. To compare glass samples by refractive index method
5. To identify and compare tool marks
6. To compare cloth samples by physical matching
7. Physical and microscopic examination of automobile paints and its spectrochemical analysis
8. Tool marks examination using comparison / stereo microscope
9. Auditory and spectrographic analysis of audio evidence for speaker identification
10. Examination and authentication of audio video recording.
11. Identification of storage media and its authentication
12. Collection of digital evidences using different softwares

(Minimum 10 Experiments to be conducted)

Text Books:

1. W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York, 1995.
2. D.R. Redsicker, The practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton, 2000.
3. Kathy Mirakovits and Gina Londino, The Basics of Investigating Forensic Science, CRC Press, 2015.
4. Franck H and Franck D, Forensic Engineering Fundamentals (1st edn), CRC Press, Boca Raton, Florida, USA, 2013.
5. Li CT, Computational Forensics, Digital Crime, and Investigation, Yurchak Printing Inc, Hershey, USA, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	1	1	2	3
CO2	1	1	1	1	1	1	1	2	2
CO3	1	1	1	1	1	1	1	2	2
CO4	2	1	1	1	1	1	1	2	2
CO5	2	1	1	1	1	1	1	2	3
CO6	1	2	1	1	1	1	1	2	3

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20FS2010	Cyber Forensics Laboratory	L	T	P	C
		0	0	3	2

Enable the student to

1. develop their skills identify, seize and preserve digital evidence from crime scenes and identify hidden files
2. have a competence in the skills required to use digital signatures for securing e-mail and online transactions
3. have the hands on training to carry out imaging of hard disks

Course Outcomes:

The student will be able to

1. identify encrypted files and IP address of the sender e – mails
2. detect, seize and preserve digital evidence from crime scenes
3. recognize hidden files
4. demonstrate concealment techniques using cryptographic PGP
5. carry out imaging of hard disks
6. identify encrypted files.

LIST OF EXPERIMENTS

1. To identify, seize and preserve digital evidence from crime scenes.
2. To detect deletions, obliterations and modifications of files using encase software.
3. To trace routes followed by e-mails and chats.
4. To identify the IP address of the sender of e – mails.
5. To demonstrate concealment techniques using cryptographic PGP.
6. To identify encrypted files.
7. To identify hidden files.
8. To use digital signatures for securing e-mail and online transactions.
9. To acquire data from PCs/laptop/HDDs/USBs, open drives, memory cards and SIM cards.
10. To use symmetric and asymmetric keys for protection of digital record.
11. To carry out imaging of hard disks.

(Minimum 10 experiments to be conducted)

Text books

1. Computer Forensics : Investigating Network Intrusions and Cyber Crime, EC-Council, ISBN-13: 978-1-4354-8352-1, ISBN-10: 1-4354-8352-9
2. Computer Forensics : Investigating Wireless Networks and Devices, EC-Council, ISBN-13: 978-1-4354-8353-8, ISBN-10: 1-4354-8353-7

3. Handbook of Digital Forensics and Investigations, Eoghan Casey ed., Elsevier Academic Press,ISBN 13: 978-0-12-374267-4

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		2	1	1		1	1	3	
CO2				1	2			1	
CO3		2					2	2	
CO4	1		1		1				1
CO5		3		2		1	1	2	1
CO6		3		2	1		2		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2011	Questioned Documents	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn examining the questioned documents using various detection apparatus
2. identify the forgery by comparing documents
3. learn to identify the forgery

Course Outcomes:

The student will be able to

1. Choose the correct method to examine the questioned documents
2. Apply various method to analyze questioned documents
3. Compare the questioned documents with standards
4. Analyze the questioned documents of various types
5. Identify the different types of forgery in the documents
6. Examine the documents that has forgery

Unit 1: Nature and Scope of Questioned Documents (7 Hours)

Definition of questioned documents. Types of questioned documents. Preliminary examination of documents. Basic tools needed for forensic documents

Unit 2 Examination of Questioned Documents (9 **Hours**)

examination – ultraviolet, visible, infrared and fluorescence spectroscopy, photomicrography, microphotography, visible spectral comparator, electrostatic detection apparatus. Determining the age and relative age of documents.

Unit 3: Comparison of Documents (12 Hours)

Comparison of handwriting. Development of individuality in handwriting. Natural variations and fundamental divergences in handwritings. Class and individual characteristics.Merits and demerits of exemplar and non-exemplar samples during comparison of handwriting. Standards for comparison of handwriting.Comparison of paper, ink, printed documents, typed documents, Xeroxed documents.

Unit 4: Forgeries (9 Hours)

Alterations in documents, including erasures, additions, over-writings and obliterations.Indented and invisible writings. Charred documents.

Unit 5: Examination of forgery (8 Hours)

Examination of counterfeit Indian currency notes, passports, visas and stamp papers. Disguised writing and anonymous letters.

Text books:

1. O. Hilton, Scientific Examination of Questioned Documents, CRC Press, Boca Raton (1982). 2. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, Foundation Press, New York (1995).
2. R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, London (2000).
3. E. David, The Scientific Examination of Documents – Methods and Techniques, 2nd Edition, Taylor & Francis, Hants (1997).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3

CO1		3	2			1	2	3	1
CO2		3		2	1		1	3	2
CO3		3	1	2			2	3	1
CO4		3		1	2		2	3	1
CO5		3			2	1		3	2
CO6		3	1		2		2	3	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2012	Questioned Documents Laboratory	L	T	P	C
		0	0	2	2

Course Objectives:

Enable the student to

1. identify the forgery by analyzing the handwriting
2. identify forgery by comparing handwriting
3. analyze the security features

Course Outcomes:

students will be able to

1. record variations in handwriting
2. compare the handwriting pattern
3. differentiate various types of forgeries
4. find defects in handwriting samples
5. compare the documents
6. analyze computer printouts

LIST OF EXPERIMENTS

1. To identify handwriting characters
2. To study natural variations in handwriting
3. To compare handwriting samples.
4. To detect simulated forgery
5. To detect traced forgery
6. To study the line quality defects in handwriting samples.
7. To examine the security features of currency notes, passports and plastic money.
8. To study alterations, obliterations and erasure in handwriting samples.
9. Identification of normal / disguise writing
10. Examination of computer printouts.

(Minimum 10 experiments to be conducted)

Text books:

R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, London (2000).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		3				1	2	3	1
CO2		3		2		1	2	3	1
CO3		3				2	2	3	1
CO4		2		3			1	3	2
CO5		2				1	1	3	2
CO6		3		1		2	2	3	1

'3'-High, '2'- Medium, '1'-Low, '-'No correlation

20FS2013	Forensic Dermatoglyphics Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student

1. Understand the principle of recording fingerprints
2. Know ridge tracing and ridge counting

3. Understand the methodology of fingerprint detection

Course Outcomes:

The student will be able to

1. know the fundamental principles on which the science of fingerprinting is based.
2. understand the method of classifying criminal record by fingerprints
3. know about the tools required for examination of fingerprints.
4. know about ridge tracing and ridge counting
5. examine the significance of foot prints
6. know about physical methods to identify fingerprints

LIST OF EXPERIMENTS

1. To record plain and rolled fingerprints
2. To carry out ten digit classification of fingerprint.
3. To identify different fingerprint patterns
4. To identify core and delta
5. To carry out ridge tracing and ridge counting.
6. To investigate physical methods of fingerprint detection.
7. To investigate chemical methods of fingerprint detection.
8. To use different light sources for enhancing developed fingerprints
9. To prepare cast of foot prints.
10. Analyzing Bite mark casting and comparison
    (Minimum 10 experiments to be conducted)

Text Books:

1. J.E. Cowger, Friction Ridge Skin, CRC Press, Boca Raton, 1983.
2. D.A. Ashbaugh, Quantitative- Qualitative Friction Ridge Analysis, CRC Press Boca Raton, 2000
3. C. Champod, C. Lennard, P. Margot and M. Stoilovic, Fingerprints and other Ridge Skin Impressions, CRC Press, Boca Raton, 2004.
4. 4Lee and Garnsleen's, Advances in Fingerprint Technology, 3rd Edition, R.S. Ramotowski (Ed.), CRC Press Boca Raton, 2013.
5. O. Hilton, Scientific Examination of Questioned Documents, CRC Press, Boca Raton, 1982.
6. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, Foundation Press, New York, 1995.
7. R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, London, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	1	1	2	3
CO2	-	1	1	1	1	1	1	2	3
CO3	-	2	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	-	1	1	1	1	1	1	2	3
CO6	1	1	1	1	1	1	1	2	3

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20FS2014	Forensic Biology and Serology -I	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the significance of serological evidence.
2. know ethe importance of biological fluids – blood, urine, semen, saliva, sweat and milk – in crime investigations.
3. learn the usefulness of genetic markers in forensic investigations.

Course Outcomes:

The students will be able to

1. understand importance of blood fluids in forensic science
2. understand the significance of forensic semen
3. understand the importance of other body fluids in forensic science

4. analyze genetic markers and fluid stain patterns.
5. document crime scene

Unit 1: Forensic Importance of Blood (9 Hours)

Common body fluids.Composition and functions of blood.Collection and preservation of blood evidence.Distinction between human and non-human blood.Determination of blood groups.Antigens and antibodies.Forensic characterization of bloodstains.Typing of dried stains.Blood enzymes and proteins.

Unit 2: Forensic Importance of semen (9 Hours)

Semen.Forensic significance of semen.Composition, functions and morphology of spermatozoa.Collection, evaluation and tests for identification of semen.Individualization on the basis of semen examination.

Unit 3: Other Body Fluids (9 Hours)

Composition, functions and forensic significance of saliva, sweat, milk and urine.Tests for their identifications.

Unit 4: Genetic Marker Analysis (9 Hours)

Cellular antigens.ABO blood groups.Extracellular proteins and intracellular enzymes.Significance of genetic marker typing data.Sexual assault investigations. Bloodstain characteristics. Impact bloodstain patterns.Cast-off bloodstain patterns. Projected bloodstain patterns. Contact bloodstain patterns. Blood trails. Bloodstain drying times.

Unit 5: Documentation (9 Hours)

Documentation of bloodstain pattern evidence.Crime scene reconstruction with the aid of bloodstain pattern analysis.

References:

1. W.G. Eckert and S.H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press, Boca Raton (1989).
2. G.T. Duncan and M.I. Tracey in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
3. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
4. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2					2		
CO2	3		3		2		3		
CO3	3			3			2		
CO4	3	2						2	2
CO5	3				2		3		
CO6	2			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2015	Forensic Biology and Serology Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. develop their skills to identify the hair morphology
2. determine blood group and identify stain in saliva and urine
3. prepare case reports

Course Outcomes:

The student will be able to

1. examine human hair
2. carry out microscopic examination of pollen grains and diatoms
3. identify blood groups of both fresh and dried blood samples
4. demonstrate concealment techniques using cryptographic PGP
5. handle and get the stains from Saliva and Urine
6. prepare case reports on entomology and wildlife forensics

LIST OF EXPERIMENTS

1. To prepare slides of scale pattern of human hair.
2. To examine human hair for cortex and medulla.
3. To carry out microscopic examination of pollen grains.
4. To carry out microscopic examination of diatoms.
5. To cite a crime case in which diatoms have served as forensic evidence.
6. To prepare a case report on forensic entomology.
7. To prepare a case report on problems of wildlife forensics
8. To determine blood group from fresh blood samples.
9. To carry out the crystal test on a blood sample.
10. To identify blood samples by chemical tests.
11. To identify the given stain as saliva.
12. To identify the given stain as urine.
13. To carry out cross-over electrophoresis.
14. To study the correlation between impact angle and shape of bloodstain.
15. To identify the point of convergence from the bloodstain patterns.
    (Minimum 10 experiments to be conducted)

Text Books

1. R. Saferstein, Forensic Science Handbook, Vol. III, Prentice Hall, New Jersey, digitized, 23 Jul 2008.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		1		1		1		3	
CO2		1	1	1			2	3	
CO3	3			2		1	1	2	
CO4	3		1						2
CO5	2	2	2	1	2			2	
CO6		3	1		1	1	3	1	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2016	Forensic Ballistics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about firearms and their classification
2. learn about ammunition and fire marks.
3. learn about nature of fireman injuries.

Course Outcomes:

The student will be able to

1. understand the detailed classification of firearms.
2. learn types of ammunition and headstamp markings on ammunitions.
3. classify various kinds of firing marks.
4. know the types of firearm evidences
5. understand the mechanism of formation of gunshot residues
6. identify the nature of fireman injuries.

Unit 1: Firearms (10 Hours)

History, development and classification of firearms. Weapon types and their operation. Firing mechanisms of different firearms -Internal ballistics – Definition, ignition of propellants, shape and size of propellants, manner of burning, and factors affecting the internal ballistics: lock time, ignition time, barrel time, erosion, corrosion and gas cutting -External Ballistics – Vacuum trajectory, effect of air resistance on trajectory, base drag, drop, drift, yaw, shape of projectile and stability, trajectory computation, ballistics coefficient and limiting velocity, Measurements of trajectory parameters, introduction to automated system of trajectory computation and automated management of ballistic data - Terminal Ballistics – Effect of projectile on hitting the target: function of bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, influence of range. Ricochet and its effects, stopping power

Unit 2: Ammunition and firing marks (12 Hours)

Types of ammunition. Constructional features and characteristics of different types of cartridges and bullets. Primers and priming compounds. Projectiles. Headstamp markings on ammunitions.-Various kinds of firing marks – rifling marks, base marking, chamber marking, extraction and Ejection marking. Comparison microscope – instrumentation

Unit 3: Firearm Evidence (7 Hours)

Matching of bullets and cartridge cases in regular firearms. Identification of bullets, pellets and wads fired from improvised, country made firearms. Automated method of bullet and cartridge case comparison. Determination of range of fire and time of fire.

Unit 4: Gunshot residues (7 Hours)

Mechanisms of formation of gunshot residues. Methods of analysis of gunshot residues from shooting hands and targets, with special reference to clothings.

Unit 5: Identification and nature of fireman injuries (9 Hours)

Identification and nature of fireman injuries, Shotgun, pistol, revolver, rifle, air guns. Bullet hole examinations – entry and exit hole determination, Estimation of caliber from bullet holes, Wave and cavitation effect, Bullet and trajectory though glass and other targets.Reconstruction with respect to accident, suicide, murder and self defence.

Text books

1. B.J. Heard, Handbook of Firearms and Ballistics, Wirely and Sons, Chichester (1997)
2. W.F. Rowe, Firearms identification, Forensic Science Handbook, Vol. 2, R. Saferstein (Ed.), Prentice Hall, New Jersey (1988).
3. A.J. Schwoeble and D.L. Exline, Current Methods in Forensic Gunshot Residue Analysis, CRC Press, Boca Raton (2000).
4. E. Elaad in Encyclopedia of Forensic Science, Volume 2, J.A.Siegel, P.J. Saukko and G.C. Knupfer (Eds), Academic Press, London (2000).
5. T.J. Gardener and T.M. Anderson, Criminal Evidence, 4th Ed. Wadsworth, Belmont (2001).
6. S.H. James and J.J. Nordby, Forensic Science : An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	**3**	**1**					**3**		
CO2	**3**		**2**				**3**		
CO3	**3**			**3**			**2**		
CO4	**2**	**1**						**2**	
CO5	**3**				**2**		**3**		
CO6	**1**			**1**					**2**

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2017	Forensic Ballistics Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the importance of fireman injuries.
2. learn he nature of fireman injuries
3. learn the methods for characterization of gunshot residue.

Course Outcomes:

The student will be able to

1. classify the firearms and their firing mechanisms.
2. dismantle and assemble all types of small arms
3. understand the methods of identifying firearms.
4. measure rifling details on fired bullets
5. know the characteristics of ammunition
6. understand the reconstruction of sequence of events in shooting incidents.

LIST OF EXPERIMENTS

1. Photography and sketching of crime scene involving firearms (3 practical).
2. Collection, preservation and packing of exhibits.
3. To dismantle and assemble all types of small arms, and to record their data, lock mechanism and trigger pull.
4. To open all types of cartridges, study and record their data.
5. Determination of shot size from diameter and weight of shots/pellets.
6. To prepare sulphur cast of inside of barrels and study the rifling details, caliber, size of bore, etc.
7. Opening of parcels, various precautions, preparations of observation sheet, marking of exhibits.
8. To determine / measure rifling details on fired bullets – determination of make/model of suspected firearms firing the bullet.
9. Restoration of erased serial numbers on firearms.
10. To perform chemical tests of powder residues (Walker‟s Test) around gunshot holes in fabrics
11. Reconstruction of sequence of events in shooting incidents.
12. To conduct firing in plate glass and study direction of firing, sequence of shots.
13. Determination of distance/ direction of firing from deceased / injuries.
    (Minimum 10 experiments to be conducted)

Text books:

1. Heard, B.J; “Handbook of Firearms and Ballistics”, John Wiley, England, 1997.
2. Warlow, T.A.; “Firearms, The Law and Forensic Ballistics”, Taylor and Francis, London, 1996.
3. Sellier, K.G. et al; “Wound Ballistics and the Scientific Background”, Elsevier Pub. Co., London, 1994.
4. Jauhari M; “Identification of Firearms, Ammunition, & Firearms Injuries”, BPR&D, New Delhi.
5. Ordog, G.J; “Management of Gunshot wounds”, Elsevier Pub. Co., NY, 1983.
6. Schooeble, A.J. and Exline, L.D; “Current methods in Forensic Gunshot Residue Analysis”, CRC Press, NY, 2000

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		2	3	1
CO2		3						1	1	
CO3	1	2			3		2	2	2	2
CO4					1	3	2	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-‘No correlation

20FS2018	Moot Court for Forensic Science	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the studentto

1. Collect the samples for evidence
2. Analyze the sample
3. Enhance the communication skill

Course Outcomes:

The student will be able to

1. know the methods of collecting evidences from the crime scene
2. analyze the evidences
3. enhance the reasoning ability
4. improve communication skill
5. draft the documents
6. improve analytical skill

LIST OF EXPERIMENTS

A moot court is an activity in which students take part in simulated court proceedings, which usually involves participating in oral argument and draft documents. The student has to study the already solved case in Indian and Foreign court of law and explain how it was solved with the help of scientific aids. (It is a role play by students as forensic experts of different discipline ie. DNA, Fingerprint, Pathologist, Forensic Botanist etc) The course involves registration of the case,Proceeding to the spot with Experts, Collection of evidence to prove the crime, Place of occurrence and to connect the crime and thecriminal, Collection of evidence from the Scene of crime, Victim, Accused.
(Sample cases are given, Other cases may be chosen)

1. The 16-year-old Gudiya went missing on July 4, 2017 while returning from school. She was kidnapped, gang-raped and brutally murdered.The girl's body was found in the forest on July 6 and the post-mortem report confirmed rape.The case was handed over to the CBI by the Himachal Pradesh High Court. Bring to the court the admissible evidence that helped in solving the case.
2. Chandigarh Police registered a case on May 25, 2009, as per which two taxi drivers Amar Lal and Davinder Singh were murdered by accused Lalit Kumar, Pardeep Kumar and Anil Kumar. The accused had robbed Rs 8,000 and car of Davinder Singh and Amar Lal in the ditches of Morni hills and Sahmbu Barrier respectively. Produce to the court admissible and relevant forensic evidences to solve case as murder.
3. Everything pointed to Bell as the main suspect after the horrendous crime was committed in 1981, Bell, however, maintained his innocence. After the development of forensic investigation and the analysis of the evidence found at the scene of the crime,At the end of March 2017, the Birmingham Crown Court, England, found Osmond Bell (60) guilty of murdering his ex-wife, Nova Walsh (24), 36 years ago. Bell could not be charged with the homicide and was released soon after his arrest due to lack of evidence. For years the case remained open and without suspects. The victim's family asked the court for a new review of the evidence involved in the case. In 2014, forensic scientists carried out further analysis of the evidence and proved Bell guilty. As a forensic expert bring to court the evidences that helped in solving the crime.
4. Jeffrey MacDonald case:Early in the morning of February 17, 1970, the family of Army doctor Jeffrey MacDonald was attacked, leaving the doctor's pregnant wife and two young daughters dead from multiple stab wounds. MacDonald himself was injured by what he claimed to be four suspects, but he survived with only minor wounds. Doubt was immediately cast on the doctor's story, based on the physical evidence on the scene that suggested that he was the killer. However, the Army dropped the case because of the poor quality of the investigative techniques. Several years later, though, MacDonald was brought to trial in a civilian court. Key evidence was provided by a forensic scientist. Produce in court the evidences accepted to prove the case.
5. Ross Compton, 60, was indicted in January for aggravated arson and insurance fraud for allegedly setting fire to his Court Donegal house. The blaze caused nearly $400,000 in damages.Show case how with the help of forensic evidences Ross Compton was found guilty.
6. Bernard Josephs returns to his house in Bromley, England, and finds his wife Claire lying under the bed, her throat slashed and severed to the spine. Defensive wounds to her hands appeared to be caused by a serrated knife. No weapon was found at the Josephs' house, and police had no other clues to go on. However, the murder was solved, and the killer convicted within four months, through solid forensic investigation.Bring light to this court the forensics evidences used to solve the case.
7. When the bodies of 10-year-old schoolgirls Holly Wells and Jessica Chapman were discovered in a ditch in Suffolk, England, the horrific crime baffled the local community.Forensic botanist Patricia Wiltshire was brought in to investigate the scene. This case proved that even the smallest, silent witnesses can provide crucial information toward solving a crime. Trace the case and submit to the court the evidences used by forensic botanist to solve the case.
8. Sister Abhaya a Catholic sister, was found dead in a water well in St Pius Convent in Kottayam on 27 March 1992. Investigation into this death is by far the longest running murder investigation in the State of Kerala.The local police which investigated the case initially closed it with a theory of suicide. The Crime Branch which took up the investigation later tried to strengthen the suicide theory, with claims of psychological illness of the deceased. On a writ petition, the High Court of Kerala transferred the investigation to the Central Bureau

of Investigation. The first team of CBI failed to find the reason of death. Upon the instruction of the court a second team was set up, which concluded that it was indeed a murder, but there were not enough evidence leading to the murderer(s). Court installed a third team of CBI, and they finally found two priests and a sister responsible for the murder and arrested them on 19 November 2008. On 17 July 2009, charges of murder, and destruction of evidence were filed against the three. Bring to court the evidences used in proving the guilty in the case.

9. Sabir Malik from Ghaziabad in Uttar Pradesh and his accompliances had allegedly committed a burglary at the house of businessman LalitBatra in December 2006. They made away with Rs 30,000 Jewellery and other valuables. The crime remained insolved and declared a blind case as identities of the suspect could not be established despite all efforts. But in 2006 the investigators solved the crime and arrested the suspect. Present the forensic evidence that helped the police to solve the case.\
10. Around 2 a.m. on the night of September 19, 1910, Clarence Hiller woke to the screams of his wife and daughter in their home at 1837 West 104th Street in Chicago. After a spate of robberies, residents of this South Side neighborhood were already on edge. Hiller, a railroad clerk, raced to confront the intruder. In the ensuing scuffle, the two men fell down the staircase. His daughter, Clarice, later recalled hearing three shots, followed by her mother screaming upstairs. Neighbors came running but the man had fled the home, leaving a dying Hiller by his front door.

20FS2019	Cyber Crimes and Cyber Forensics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basics of computers
2. know about cyber crimes
3. understand the principle of investigating cyber crimes

Course Outcomes:

The student will be able to

1. know the principle of operation of computer hardware and accessories
2. understand the types of computer crimes
3. know crimes related to intellectual property rights, computer terrorism and hacking
4. understand the concept of collecting of magnetic data
5. know about extraction of information from the hard disk
6. understand the principle of restoration of deleted files, encryption and decryption methods.

Unit 1: Computer fundamentals (9 Hours)

Fundamentals of computer hardware and accessories, development of hard disk, physical construction, CHS and LBA addressing, encoding methods and formats - Memory and processors – methods of storing data, Operating systems, Networks – LAN, WAN and MAN.

Unit 2: Cyber crimes – I (9 Hours)

Definition - computer crimes - Distinction between computer crimes and conventional crimes.Reasons for commission of computer crimes - Breaching security and operation of digital systems - Computer virus, and computer worm – Trojan horse, trap door, super zapping, logic bombs.

Unit 3: Cyber crimes – II (9 Hours)

Types of computer crimes – computer stalking, pornography, hacking, crimes related to intellectual property rights, computer terrorism, hate speech, private and national security in cyber space - An overview of hacking, spamming, phishing and stalking.

Unit 4: Computer Forensic Investigations – I (9 Hours)

Seizure of suspected computer - Preparation required prior to seizure - Collection and seizure of magnetic data, Treatment of exhibits, Extraction of information, Restoration of deleted files – familiarization of software, Encase, Cyber check suites, Encryption and decryption methods. Protocol to be taken at the scene.

Unit 5: Computer Forensic Investigations – II (9 Hours)

Extraction of information from the hard disk - Treatment of exhibits. Creating bitstream of the original media - Collection and seizure of magnetic media - Legal and privacy issues. Examining forensically sterile media - Restoration of deleted files. Password cracking and E-mail tracking -Encryption and decryption methods - Tracking users.

Text Books:

1. R.K. Tiwari. Sastry and K.V. Ravikumar, Computer Crimes and Computer Forensic, Select publishers, New Delhi, 2003.
2. C.B. Leshin, Internet Investigations in Criminal Justice, Prentice Hall, New Jersey, 1997.
3. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey, 2004.
4. E. Casey, Digital Evidence and Computer Crime, Academic Press, London, 2000.
5. Nina Godbole and Sunit Belapore, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley Publications, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	2	1	1	1	1	1	-	3
CO2	1	2	1	1	1	1	1	-	3
CO3	1	2	1	1	1	1	1	-	3
CO4	-	2	1	1	1	1	1	-	3
CO5	-	2	1	1	1	1	1	-	3
CO6	1	2	1	1	1	1	1	2	2

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20FS2020	Fundamentals of Forensic Psychology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. overview of forensic psychology and its applications
2. understand psychology and criminal behavior.
3. learn about tools for detection of deception.

Course Outcomes:

The student will be able to

1. overview of forensic psychology and its applications.
2. explain legal aspects of forensic psychology.
3. describe the significance of criminal profiling.
4. outline the importance of psychological assessment in gauging criminal behavior.
5. illustrate the tools and techniques required for detection of deception.
6. demonstrate the critical assessment of advanced forensic techniques like polygraphy, narcoanalysis and brain electrical oscillation signatures.

Unit 1: The Science of Psychology (8 Hours)

Concepts of psychology, History of psychology, modern perspectives, types of psychological professionals psychology, The science and research methods, professional and ethical issues in psychology

Unit 2: Theories of Personality (9 Hours)

Understanding personality, type and Trait, theories of personality, psychoanalytic model, ehavioristic model social cognitive model, Humanistic model, Biologicalmodel assessment of personality.

Unit 3: Basics of Forensic Psychology (9 Hours)

Definition and fundamental concepts of forensic psychology and forensic psychiatry. Psychology and law. Ethical issues in forensic psychology.Assessment of mental competency. Mental disorders and forensic psychology. Psychology of evidence – eyewitness testimony, confession evidence. Criminal profiling. Psychology in the courtroom, with special reference to Section 84 IPC.

Unit 4: Psychology and Criminal Behavior (10 Hours)

Psychopathology and personality disorder. Psychological assessment and its importance.Serial murderers. Psychology of terrorism.Biological factors and crime – social learning theories, psycho-social

factors, abuse. Juvenile delinquency – theories of offending (social cognition, moral reasoning), Child abuse (physical, sexual, emotional), juvenile sex offenders, legal controversies.

Unit 5: Detection of Deception (9 Hours)

Tools for detection of deception – interviews, non-verbal detection, statement analysis, voice stress analyzer, hypnosis.Polygraphy – operational and question formulation techniques, ethical and legal aspects, the guilty knowledge test.Narco analysis and brain electrical oscillation signatures – principle and theory, ethical and legal issues.

Text books

1. M J.Baron, R.A. Kolsher,"Psychology: from science to Practice", Pearson, 2nd edition, 2007.
2. C. Cronin, "Forensic Psychology", Kendall Hunt Pub Co; 2nd edition, 2009.
3. C.R. Bartol, A.M.Bartol, "History of Forensic Psychology", John Wiley & Sons Inc., 2014.
4. V. Veeraraghavan,"Textbook of Criminology", Selective & Scientific Books, 2018.
5. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, "Scientific Evidence in Civil and riminal Cases", 4th Edition, The Foundation Press, Inc., New York, 1995.
6. R. Saferstein, "Criminalistics", 8th Edition, Prentice Hall, New Jersey, 2004.
7. J.C. DeLadurantey, D.R. Sullivan, "Criminal Investigation Standards", Harper & Row, New York, 1980.
8. J. Niehaus, "Investigative Forensic Hypnosis", CRC Press, Boca Raton, 1999.
9. J. Siegel, P. Saukko"Encyclopedia of Forensic Sciences,"2nd edition, J, Academic Press,2013.
10. R.S.Fieldman "Understanding Psychology",McGraw Hill Education, Twelfth edition, 2017.
11. B.B Lahey,"Psychology: An introduction",McGraw-Hill Education; 11th edition, 2011.
12. J.WKalat,"Introduction to Psychology",Cengage Learning; 11th edition, 2016.
13. Clifford T. Morgan, Richard A. King, John R. Weisz, John Schopler,"Introduction to Psychology", McGraw-Hill Education, 7th edition, 2001

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2		3	2		1	3	1	
CO2	3	2	1	2	1	3	1		3
CO3				2		2	2	1	
CO4	1		2	3			3		
CO5	2	1			2		2	3	
CO6	2	1			2	3	2	3	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2021	Crime Scene Investigation	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the concepts of crime and crime scene
2. know about documentation of crime scene
3. know about preservation of evidences

Course Outcomes:

The student will be able to

1. know the reasons for committing crime and types of crime scenes
2. understand the objectives of documentation and evidence classification
3. know the methods relevant to crime scene documentation
4. understand the methodology of collecting, packaging and preservation of evidences
5. understand the concepts of crime scene reconstruction
6. know about stages of crime scene reconstruction

Unit 1: Crime and crime scene – I (9 Hours)

Definition of crime - IPC and crime – mensrea - reasons for committing crime in India and worldwide - Crime scene, Types of crime scenes: primary, secondary, indoor, outdoor - Role of different agencies involved in crime scene management: police medico legal experts, judicial officers.

Unit 2: Crime and crime scene – II (9 Hours)

Actions of initial responding officer - objectives - Documentation: statements of victim,witness suspects, database and records, officer safety, emergency care, secure and control, release scene to appropriate authorities - Locards principle of exchange - concept of evidence – evidence classification - direct ,circumstantial physical, biological, corroborative, conclusive, trace, testimonial.

Unit 3: Documenting crime scene (9 Hours)

Documenting crime scene: crime scene photography, crime scene notes - Crime scene sketching: indoor and outdoor, triangulation method, baseline method, polar coordinate method - Search: definition, objectives search patterns - strip method, grid method, zone/quadrant method spiral method (inward and outward), point to point method, wheel method.

Unit 4: Preservation of evidences (9 Hours)

Collection, packaging and preservation of evidences and general considerations -Physical evidences: fingerprints, impressions (tyreprints, footprints, lipprints, bitemarks), fiber, trace evidences (glass, soil, paint) firearms and tool marks, explosive materials, questioned documents - Biological evidences: body fluids (blood, urine, semen, secretions), tissue, hair, nail.

Unit 5: Crime scene reconstruction (9 Hours)

Cases of special consideration: arson, mass disasters-their scene management and evidence collection for human identification - Crime scene reconstruction: introduction, importance , nature and principles: recognition, identification, individualization and reconstruction, stages: data collection, conjecture, hypothesis formulation, testing, theory formation.

Text Books:

1. Barry A. J. Fisher, Barry A. J. Fisher, David R. Fisher, David R. Fisher, Techniques of crime scene investigation, CRC Press, 2012.
2. Tom Bevel, Ross M. Gardner, Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction, 3rd Edition, CRC Press, 2008.
3. Suzanne Bell, Forensic Science: An Introduction to Scientific and Investigative Techniques, Fifth Edition, CRC Press, 2019.
4. StuartHJames *and* JonJNordby, An Introduction To Forensic Scientific and Investigative Techniques, Third Edition, CRC Press, 2007
5. W. Jerry Chisum and Brent E. Turvey,Crime Reconstruction, Elsevier academic press, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	-	3
CO2	1	2	1	1	1	1	1	2	3
CO3	1	2	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	-	1	1	1	1	1	2	2	2
CO6	1	1	1	1	1	1	1	2	2

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20FS2022	DNA Typing	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of DNA analysis and Typing
2. obtain knowledge on parentage testing
3. be exposed to report writing in DNA typing

Course Outcomes:

The student will be able to

1. recognize the basic principle of DNA analysis
2. apply the forensic significance of DNA typing
3. understand the importance of short tandem repeats and restriction fragment length polymorphism in DNA technique
4. comprehend the principles of parentage testing
5. write a detailed report on DNA typing

6. analyse the probability determination in a population database

Unit 1: Basic Principles (7 Hours)

DNA as biological blueprint of life.Extraction of DNA for analysis. Quantitation of DNA – yield gel quantitation and slot blot quantitation. Mitochondrial DNA – sequence analysis.

Unit 2: Forensic DNA Typing (10 Hours)

Collection of specimens.Polymerase chain reaction – historical perspective, sequence polymorphisms, individualization of evidence.

Unit 3: Short Tandem Repeat (STR) in DNA Technique (10 Hours)

Short tandem repeats (STR) – role of fluorescent dyes, nature of STR loci. Restriction fragment length polymorphism (RFLP) – genetic markers used in RFLP, typing procedure and interpretation of results. Touch DNA.

Unit 4: Parentage Testing (10 Hours)

Principles of heredity.Genetics of paternity. DNA testing in disputed paternity. Mandelian laws of parentage testing. Mathematical basis of parentage identification.Missing body cases.Reference populations and databases.

Unit 5: Report Writing (8 Hours)

Role of DNA typing in identifying unrecognizable bodies - Allele frequency determination.Hardy-Weinberg law.Probability determination in a population database.

Text books

1. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
2. J.M. Butler, Forensic DNA Typing, Elsevier, Burlington (2005).
3. K. Inman and N. Rudin, An Introduction to Forensic DNA Analysis, CRC Press, Boca Raton (1997).
4. H. Coleman and E. Swenson, DNA in the Courtroom: A Trial Watcher's Guide, GeneLex Corporation, Washington (1994).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			1					2	
CO2			2	2	1	2	1	1	
CO3		1	3					3	
CO4				3	1				
CO5	1	3	1	2		1	2	2	1
CO6	1	2	2	1		1	1	1	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2023	Forensic Medicine	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. explore the death investigations and crime scene management
2. obtain knowledge on evidence processing
3. be exposed to autopsy techniques

Course Outcomes:

The student will be able to

1. do the duties of the first responding officer who receives a call on homicide or suicide case
2. practice the steps involved in processing the death scene
3. explore the crime scene management in death cases
4. understand the process of collecting and documenting the evidences in death cases
5. realise the importance of autopsy
6. tio understand the changes happening after death

Unit 1: Death Investigations (9 Hours)

Fundamental aspects and scope of forensic medicine -Approaching the crime scene of death.Obtainingfirst hand information from the caller.Rendering medical assistance to the victim, if alive.Protectinglife.Recording dying declaration. Identifying witnesses and, if possible, suspect.

Interviewing onlookers and segregating possible witnesses. Suspect in custody – initial interrogation and searching for evidence. Miranda warning card.

Unit 2: Crime Scene Management in Death Cases (9 Hours)

Assessing the crime scene.Request for forensic team.Importance of command post and log book.Management of crowd and media.Importance of taking notes.Items to be a part of noting.Documenting the death scene.

Unit 3: Processing the Evidence (9 Hours)

Processing evidence.Evaluation of injuries.Importance of canvass form.Indexing the death investigation. Handling buried body cases – search for buried bodies, methods of exhumation. Suicide cases – evaluating the type of injuries, gauging the psychological state of victim, suicide notes.

Unit 4: Autopsy (12 Hours)

Forensic pathology.Medico-legal aspects of death.Causes of death.Determination of time since death.Investigation of sexual offences.Death by drowning.Injuries.Types and classification of injuries.Antemortem and post mortem injuries.Aging of injuries.Artificial injuries.

Unit 5: Changes after Death (6 Hours)

Early changes- Rigor mortis - postmortem hypostasis – Body cooling – Estimation of time of Death

Text Books:

1. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).
2. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton, 1st edition, 22 August 2012.
3. K. Smyth, The Cause of Death, VanNostrandReinhold, New York, 1 April 1983.
4. M. Bernstein, Introduction to Forensic Sciences, 2nd Ed., W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
5. J. Dix, Handbook for Death Scene Investigations, CRC Press, Boca Raton (1999).
6. H.B. Baldwin and C.P. May in, Encyclopedia in Forensic Science, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
7. V.J. Geberth, Jean Schimpff, Hans-JorgSenn, Practical Homicide Investigation, CRC Press, Boca Raton, 4th Edition, 8 February 2006.
8. Shepherd R. "Simpson's Forensic Medicine", 12th Edition,A Hodder Arnold Publication, 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1		2			3	3		2
CO2		1		1	2	1			1
CO3				2	3	1	2	3	
CO4	2	3	1	1				3	
CO5		2	1		1		3	2	2
CO6		1			1		3	2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2024	Forensic Anthropology and Odontology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand basics of forensic anthropology
2. know about ossification and its importance
3. learn the chemistry of bones

Course Outcomes:

The student will be able to

1. know the importance of skeletal system
2. understand the anatomy of different bones
3. understand the chemistry of bones and biological profiling
4. know the facial anatomy of humans and facial superimposition
5. know about forensic odontology and recovery of forensic evidences from graves

6. understand about skeletal variation.

Unit 1: Introduction to forensic anthropology (9 Hours)

Forensic Anthropology - Introduction, definition, history, scope and importance - Skeletal system - Structure and functions - Bones: identification and classification - Characteristics of bones - Anatomy of bones.

Unit 2: Ossification and its importance (9 Hours)

Ossification - Introduction and importance - Anatomy of different bones – the skull, clavicle, scapula and ribs, vertebral column, Humerus radius ulna, carpals, metacarpalsd and phalanges, pelvis, Femur tibia, fibula, patella, tarsals, metatarsals.

Unit 3: Chemistry of bones (9 Hours)

Chemistry of bones - field and laboratory management of skeletal remains - Biological profiling or skeletal remains - Demography, sex, age, stature and race estimation.

Unit 4: Application in investigation (9 Hours)

Facial reconstruction: two and three dimensional methods, facial anatomy of humans, facial tissue, thickness with MRI and other methods - Facial superimposition: comparison and analysis of facial features of human skull and the antemortem photograph - Superimposition: photographic and computerized methods

Unit 5:Forensic Odonotology (9 Hours)

Forensic Odontology: introduction, definition, history and scope - Teeth : types and structures, age determination and role in personal identification - Recovery of forensic evidences from graves and skeletal variation.

Text Books:

1. Angi M. CHoursistensen, Eric Bartelink and Nicholas V. Passalacqua, Forensic Anthropology : Current Methods and Practice, Elsevier, 2014.
2. Jane A. Taylor and Jules A. Kieser, Forensic Odontology : Principles and Practice, John Wiley & Sons, Ltd., 2016
3. Tim D. White and Pieter A. Folkens, The Human Bone Manual, Elsevier, 2005.
4. Karen Ramey Burns, Forensic Anthropology Training Manual, Pearson Education Inc., 2013.
5. Mark Nielsen and Shawn D. Miller, Atlas of Human Anatomy, 1st edition, Kindle edition, 2011.
6. Omar Faiz, Simon Blackburn and David Moffat, Anatomy at a Glance, 3rd edition, Kindle edition, Wiley Blackwell, 2011.
7. Gale Sloan Thompson, Understanding Anatomy&Physiology: A Visual, Auditory, Interactive Approach, 2nd edition, F.A. Davis Company, 2015

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	-	-	-	-	1	1	1	1	2
CO2	-	-	-	-	1	1	1	-	3
CO3	-	-	-	-	1	1	1	-	3
CO4	-	2	-	-	1	1	1	-	3
CO5	-	-	-	-	1	1	1	-	3
CO6	-	2	1	1	1	1	1	2	2

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20FS2025	Accident Investigation	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of dna analysis and typing
2. obtain knowledge on parentage testing
3. be exposed to report writing in dna typing

Course Outcomes:

The student will be able to

1. realize the background of vehicle accidents
2. analyze motor accidents
3. assess the post-crash movement

4. do systematic analysis of injuries in accidents
5. perform the tachographic data analysis
6. analyse the falsification and diagnostic signals

Unit 1: Motor Vehicle Accidents (9 Hours)

Accident scene.Sources of forensic information. Eyewitness accounts. Extent of vehicle damage.Visibilityconditions.Photographs of accident site.

Unit 2: Analysis of Motor Accidents (9 Hours)

Estimation of speed. Tire marks, skid marks, scuff marks. Maintenance of vehicles.Abandonedvehicles.Importance of air bags.Railway accidents.

Unit 3: Accident Analysis(9 Hours)

Post-crash movement.Collisionmodel.Gauging driver's reaction.Occupants's kinematics.

Unit 4: Analysis of Injuries (9 Hours)

Types of injuries resulting from accident.Biomechanics of injuries. Hit and run investigations. Trace evidence at accident sites.

Unit 5: Tachographs(9 Hours)

Forensic significance of tachograph data. -achograph charts. Principles of chart analysis.Accuracy of speed record - Tire slip effects. Falsification and diagnostic signals -Route tracing.

Text Books:

1. S.C. Batterman and S.D. Batterman in Encyclopedia of Forensic Sciences, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
2. T.S. Ferry, Modern Accident Investigation and Analysis, Wiley, New York (1988).
3. D. Lowe, TheTachograph, 2nd Edition, Kogan Page, London (1989).
4. T.L. Bohan and A.C. Damask, Forensic Accident Investigation: Motor Vehicles, Michie Butterworth, Charlottesville (1995).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	2	2	2		1	1	
CO2				1				2	
CO3		1	3		1		2	1	
CO4	1			1					
CO5	1	2	1		2	1	2	3	
CO6		2		1			1	2	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2026	Forensic Biology And Serology -II	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. genetic variation
2. the methods of sterelization
3. the classification and characteristics of blood samples

Course Outcomes:

students will be able to

1. to know about the measures of genetic variation
2. determination of species of origin-ring test
3. testing procedures and factor effecting
4. human blood group systems
5. new approaches in bloodstain grouping
6. non-genetic approaches to individualization

Unit 1: Human genetic variations (9 Hours)

Human genetic variations. Mendelian Inheritance. Hardy Weinberg Equilibrium. Mutation- their types and causes. Relevance of population genetics. Allele frequency, genotype frequency. Polymorphism and heterozygosity. Measures of genetic variations.

Unit 2: Bloodstain Pattern Analysis (9 Hours)

Bloodstain characteristics. Impact bloodstain patterns. Cast-off bloodstain patterns. Projected bloodstain patterns. Contact bloodstain patterns. Blood trails. Bloodstain drying times.
Documentation of bloodstain pattern evidence. Crime scene reconstruction with the aid of bloodstain pattern analysis.

Unit 3: Biological evidence-I (9 Hours)

Hair – significance, transfer and recovery, structure of human hair, Morphology and biochemistry of human hair, Comparisons of hair samples, Comparison of human and animal hairs.

Unit 4: Biological evidence-II (9 Hours)

Types and identification of microbial organisms of forensic significance - Diatoms and their forensic significance, structure and analysis of skull and bones.

Unit 5: Forensic Entomology (9 Hours)

Insects of forensic importance, Collection of entomological evidence during death investigations. General Entomology- significance of terrestrial and aquatic insects in forensic investigations and their role in crime detection, Insect's succession and its relationship to determine time since death. Impact of ecological factors on insect's developments.

Text books

1. Goodwin, William; "An Introduction to Forensic Genetics", John Wiley & Sons Ltd., 2007.
2. Kapur, V; "Basic Human Genetics", Jaypee Brothers, 1991.
3. Kothari, Manu L; "Essentials of Human Genetics", University Press (India) Pvt. Ltd., 2009. 4. Singh B.D.; "Fundamentals of Genetics", Kalyani Publishers, 2006.
5. Edmund Sinhott; "Principles of Genetics", McGraw Hill Publications, 1950.
6. Giblett, Eloise R.; "Genetic Markers in Human Blood", Blackwell Scientific Publications, 1969.
7. Altenburg, Edgar; "Genetics", Oxford & IBH Publishing Co., 1970.
8. GJV Nossal; "Antigens, Lymphoid Cells and the Immune Response", Academic Press, 1971.
9. Wiener, Alexander S; "Advances in Blood Grouping II", Grune& Stratton, 1965.
10. Boorman, Kathleen E & Churchill; "Blood Group Serology", Livingstone, 1977.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2					3	1	
CO2	3		1				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2027	Modern Techniques in Explosives and Bomb Detection	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. analyze trace amounts of petroleum products in crime scene evidence.
2. analyze contaminants in petroleum products
3. classify and characterize of the narcotics, drugs and psychotropic substances.

Course Outcomes:

students will be able to

1. know about chemistry of explosives petroleum products forensic science.
2. understand about the blasting agents
3. know the bomb initiating mechanism.
4. know the explosive detection methods
5. know the bomb disposal equipments.
6. understand about dog in detection of explosives and handler team

Unit 1: Introduction to Explosives (9 Hours)

Definition for explosives, History of explosives, Classification of explosives, high & low explosives, Properties of explosives, Basic Explosive terms, Explosive substances, Detonation, Smokeless powder, Improvised low explosive substances, Flexible Sheet Explosives, Secondary High Explosive Substances,

Detonating Cord, Boosters, Blasting Accessories, Initiation of Explosives, Working of Explosives, Explosive Train, Blast Effects.

Unit 2: Blasting Agents (9 Hours)

RDX,PETN,TNT,HMX,CE, Lead azide-Silver azide-Fulminate of mercury-Lead styphnate-Tetrazene-Plastic Explosive C4,Semtex PEK-Sheet explosives-Combination of explosives-Low explosives-Black Powder-Pyrotechnics-Civil explosives-Permitted and non permitted explosives-Dynamite-Ammonium nitrate-ANFO,Ggelatine-Slurries and wartergel-Blasting accessories.

Unit 3: Explosive Detection Methods (9 Hours)

Explosive Detection Principles, Limitation of explosive, Vapour Detections, Principles of explosive detection system, Electron capture detection system (ECD), Gas Chromatography (GC), Ion Mobility spectrometry (IMS), Thermal Neutron Analysis, Microwave Technology, Ion Trap Mass spectrometry(ITMS), Surface acoustic Wave, Chemiluminescence, Nuclear Quadrupole resonance (NQR), Back scatter X-ray-Penetrating, Electromagnetic Radiation, Marking of Explosives, Tagging of explosives, Explosive Detection by chemical method.

Unit 4: Bomb Detection and Disposal Equipments (9 Hours)

Bomb Detection System, Quantitative requirement of explosive detection Equipments, Detection by trained team, Explosive Detectors , Letter Bomb detector , Walkthrough explosive detection system, Buster Contraband detector, Metal Detectors, Computer aided detection, Protection equipment, Disposal equipment, Hand entry technique, Remote entry techniques, burning technique, Remote opening letter bomb, Transportation and final disposal ,Dos and Don'ts.

Unit 5: Dog in Detection of Explosives and Handler Team (9 Hours)

Why dogs are preferred, Selection Procedure, Training technique, Summary of find rate, Bomb incident investigation, Reasons for bombing, Qualities of explosion investigator, Composition of investigation team, Equipment and Tools, Investigation techniques, Action on arrival of scene, Injury to persons, Seat of explosion, Fragments, Spot test, Preparation of report, Explosion investigation, Bomb Detection & Disposal Equipments.

Text books

1. Narayanan, T. V: Modern Techniques of Bomb Detection and Disposal, R. A. Security System, 1995.
2. Svehla, G. Ed.: Vogel's Qualitative Inorganic Analysis, Longman, 1998.
3. Beveridge, A: Forensic Investigation of Explosives, Taylor & Francis, 2000.
4. Yallop, H. J: Explosion Investigation, Forensic Science Society & Scottish Academic Press, 1980.
5. Yinon, J. and Zitrin, S: Modern Methods and Applications in Analysis of Explosives, John Wiley, 1993.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3	1	2				3		
CO3	3			3			2		
CO4	3	1			1			3	
CO5	3				2		3		
CO6	2			2					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2028	Foundation Course on Computer Fundamentals and Office	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student

1. Learn the fundamentals of MS office and internet.
2. Explore the concepts of C programming
3. Be exposed to ideas related to pointers

Course Outcomes:

The student will be able to

1. Analyse the fundamentals of MS Office

2. Utilize the Internet
3. Understand the fundamentals of C programming.
4. Know the basic concepts of arrays and functions in C.
5. Apply the concepts of structures in C programming.
6. Understand the concept of pointers.

Unit 1: MS Office (9 Hours)

MS word, excel, power point, Internet

Unit 2: Fundamentals of C Programming (9 Hours)

History of C -Characteristics of C - C Program Structure - Data Types - Variables and Constants - Operators - Conditional Statements - Looping and Iteration.

Unit 3: Arrays and Functions in C (9 Hours)

Single Dimensional Array -Multi Dimensional Array - Types of functions - Functions and Arrays - String Functions - Recursive Functions

Unit 4: Structures (9 Hours)

Basics, Structures and functions - Arrays of structures - Pointers to structures - Self referential structures - Typedef - Union - Bitfields - Enum Data Types

Unit 5: Pointers (9 Hours)

Pointers :introduction - declaration - passing function to pointers - pointers with arrays - dynamic memory allocation.

Text Books:

1. E. Balagurusamy , Programming in Ansi C , 6th Edition, TMG - India 2012.
2. Herbert Schildt, The Complete Reference C, 4th Edition, Tata Mc - Graw Hill, 2000.
3. Byron C Gottfried, Programming with C, Schaums' outline series 2nd Edition, Tata Mc - Graw Hill, 2006.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3					3		
CO2	2	3	2	2	2	2	3	3	1
CO3	3	3					2	2	
CO4		2	1		2	2			
CO5	2	3					2	1	
CO6	1	2		1			1		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3001	Chemical Kinetics and Chemical Thermodynamics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basics of chemical thermodynamics
2. learn the kinetics of rate equations
3. get thorough knowledge about catalysis

Course Outcomes:

Student will be able to

1. understand the principles of chemical thermodynamics
2. know the parameters relevant to chemical thermodynamics
3. understand the types and kinetics of fast reactions
4. know the kinetics of flow techniques
5. understand the theory of acid – base catalysis
6. know about the concepts of heterogeneous catalysis

Unit 1 : Chemical thermodynamics – I (9 Hours)

Thermodynamics - State variables – Thermodynamic equilibrium - reversible process – Irreversible process – Heat and work – First law of thermodynamics - Mathematical formulation of first law of thermodynamics – Enthalpy – Relationship between ΔH and ΔE – Enthalpy of reaction – Types – The effect of temperature on ΔH – Kirchoff's equation – Hess law – Limitation of first law of thermodynamics - Second law of thermodynamics – Spontaneous process and spontaneity – Non spontaneous process – Third law of thermodynamics – Entropy – Entropy change in phase transformations – Entropy changes

of an ideal gas in different processes – Entropy at absolute zero – Determination of absolute entropies of solids, liquids and gases – Trouton's rule.

Unit 2: Chemical thermodynamics – II (9 Hours)

Gibbs free energy – Gibbs free energy and spontaneity – Prediction of feasibility of a chemical reaction – Effect of temperature on spontaneity – Helmholtz energy – Maxwell's relations – Gibbs Helmholtz equation – Applications - Thermodynamics of open systems – Partial molar properties – Chemical potential – Gibbs – Duhem equation – Variation of chemical potential with temperature and pressure – Clapeyron equation – Clapeyron – clausius equation – Applications – Activity – Activity coefficient – Ideal solution – Real solution – Fugacity – Determination of a fugacity of a gas – Chemical equilibrium – Characteristics of chemical equilibrium – Law of mass action – Equilibrium law – Equilibrium constant expression for a reaction in general terms – Van't Hoff Isotherm – Van't Hoff isochore – Relationship between K_p, K_c and K_x.

Unit 3: Chemical Kinetics – I (9 Hours)

Chemical kinetics – Basic concepts – rate law – rate equation – Kinetics of zero, first, second and third order reactions – Kinetics – composite reactions (complex reaction) – Opposing (reversible) reactions – Consecutive reactions – Chain reactions – Stationary chain reaction –Collision theory of bimolecular and unimolecular reactions – Arrehenius theory of reaction rates – Theory of absolute reaction rates – Thermodynamic treatment of reaction rate - Lindemann's theory – Kinetics of fast reactions.

Unit 4: Chemical Kinetics – II (9 Hours)

Study of kinetics of stopped flow techniques – flash photolysis – shock tubes – Reaction rates in solution – Effect of dielectric constant and ionic strength – Kinetic isotope effects – Hammett relationship - ionic reactions in solution – effect of ionic strength – Linear free energy relationships – Taft equation – Yukawa-Tsuno equation – Luminescence and energy transformations – Chemiluminescence – reactions in molecular beam.

Unit 5: Catalysis (9 Hours)

Acid – Base catalysis – general scheme – Arrhenius complex – Vant Hoff's complex – specific and general catalysis – catalytic constants – Bronsted relationship – Hammett acidity functions – mechanism of acid-base catalysed reaction – Catalysis by metal salts (transition metal complex) – enzyme catalysis – theory and applications - Mechanism of heterogeneous catalysis - Langmuir-Hinshelwood mechanism and Langmuir Reidel mechanism - Examples of heterogeneous catalytic reactions - hydrogenation of ethylene, synthesis of ammonia, oxidation of SO_2 and Fischer- Tropsch method for the synthesis of methanol.

Text books:

1. B.R., Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandhar, 2000.
2. Kundu and S.K. Jain, "Physical Chemistry" S. Chand & Company Ltd., New Delhi, 1984
3. P.W. Atkins, "Physical Chemistry", 8th edition, Oxford University Press, 2006
4. Kalidas, C. "Chemical Kinetic Methods: Principles of Relaxations Techniques and application", New Age International (P) Ltd, Chennai, 2005.

Reference Books:

1. S. Glasstone and D.Lewis, "Elements of Physical Chemistry", 2nd Ed.,1982
2. M.J. Piling and P.W. Seakins, "Reaction Kinetics", Oxford University Press, 2nd edition, 1996.
3. J. C. Kuriacose and J.Rajaram, "Thermodynamics", Shoban Lal Nagin Chand & Co., Jalandhur, 1996.
4. G.W. Castellan, "Physical Chemistry", Narosa publishing house, Chennai, 1989.
5. H. Snehe, "Comprehensive Physical Chemistry", Prgati Prakashan, Meerut, 1987.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	1	2	1	1
CO2	1	1	-	1	1	1	1	2	1	1
CO3	1	1	1	1	1	2	-	1	1	2
CO4	1	1	1	1	2	1	-	1	2	3
CO5	1	1	1	1	1	1	-	1	1	2
CO6	1	1	1	1	1	1	-	1	1	2

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3002	Theories of Chemical Bonding	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. describe the theory of acids and bases and non-aqueous solvents.
2. distinguish various types of bonding.
3. Summarize the factors affecting the strength of the bonds

Course Outcomes:

Student will be able to

1. explain the theory of acids and bases
2. summarize the importance and applications of non-aqueous solvents
3. discuss the various theories of ionic bonding.
4. describe the theories related to covalent bond
5. compare the theories of coordinate bond
6. relate the properties of coordinate bond with CFSE

Unit 1: Acid-Base Chemistry (8 Hours)

Periodicity – Bronsted-Lowry Theory – Lewis Theory – Measures of acid-base strength - Hard and Soft acids and bases – Classification – Symbiosis – Electronegativity and harness and softness

Unit 2: Non-aqueous Solvents (7 Hours)

Protic and Aprotic solvents - Leveling Effect – Reactions in Non-aqueous solvents –Liquid Ammonia – Sulfuric acid – Hydrofluoric Acid – Sulfur dioxide – Dinitrogen tetroxide

Unit 3:Ionic Bonding (9 Hours)

Lattice energy –Born Lande Equation – Born Haber Cycle – Fajan's rule – Size effects – Factors affecting the radii of ions – Radius Ratio - Structures of Compounds of types AX – NaCl, CsCl, ZnS , NiAs, Structures of type AX_2 – CaF2, TiO2 – Structures of type ABX_3 – Perovskite, Ilmenite -Crystal Systems – Defects

Unit 4:Covalent Bond (9 Hours)

VB Theory – Hybridization – MO Theory of Diatomic Molecules – Delocalization – Resonance – Electronegativity and MO Theory – Group Electronegativity - VSEPR Theory – Experimental determination of Molecular structure – Berry pseudorotation – Ion-dipole Interaction – Hydrogen Bonding

Unit 5: Coordinate bond (12 Hours)

Ligands – Classification - Formation of Complexes – Bonding theories – Werner's theory – Sidgwick Theory - VB Theory – Advantages and Defects - Crystal Field Theory – Shapes of d orbitals – Assumptions - CFSE – Measurement of 10Dq - Factors Affecting 10Dq – Spectrochemical Series – Consequences – Merits and limitations of Crystal field theory - MO Theory – sigma Bond and pi Bond – Advantages

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
3. Sharpe A.G. "Inorganic Chemistry", Dorling Kindersley (India) Pvt. Ltd, 2nd impression, 2008.
4. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, "Advanced Inorganic Chemistry" Vol I and II, S. Chand and Company Ltd, NewDelhi, India, Reprint: 2009.
5. Mido Y, Taguchi S, Sethi M.S & Iqbal S. A, "Chemistry in Aquous and Non-aqueous Solvents", Discovery Publishing House, New Delhi, 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1			1			1	2	1
CO2	2	2	2		1			1	2	
CO3	3	1		2				2	3	
CO4	3	1							3	

CO5	2				2			3	2	
CO6	1			1						

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3003	Organic Reaction Mechanism and Stereochemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the electronic effects on reaction pathway.
2. realize the various types of reaction mechanism
3. acquire knowledge about stereochemistry and asymmetric synthesis.

Course Outcomes:

Student will be able to

1. explain the role of electronic effects in predicting the reaction pathway.
2. propose the possible mechanism for organic transformation.
3. predict the product formed in the reaction by applying the mechanism
4. explain the product selectivity in the organic reactions
5. assign configuration for chiral molecule and predict stable conformer.
6. reason out for the stereoselectivity in organic reactions in the presence chiral environment

Unit 1: Electronic Effect and Aromaticity (9 Hours)

Electronic effects- Inductive effect, Resonance effect, hyperconjugation, steric effect- importance of electronic effects. Quantitative treatments of the effect of structure and reactivity – Derivation of Hammett equation–Linear Free Energy Relationship derivation – Problems on Substitution constant, reaction constant and pKacalculation using Hammett equation, significance of sigma and rho – Isotopic labelling and types of kinetic isotopic effects-prediction of mechanism. Aromaticity – Huckel's rule for smaller rings – 8, 10, 12, 14 and 16– Annulenes, heterocycles,fulvene, fulvalene, homoaromaticity.

Unit 2: Nucleophilic Substitution (9 Hours)

Aliphatic nucleophilic substitution mechanism– S_N2, S_N1, Effect of substrate, attacking nucleophile, leaving group and reaction medium, mixed S_N1 and S_N2 , S_Ni, single electron transfer mechanism, Anchimeric assistance by lone pair, alkene, aryl groups – addition to allylic carbons SN2'. Aromatic nucleophilic substitutions – Addition elimination SNAr, Effect of substrate, leaving group and attacking nuclephile. Elimination Addition-benzyne, generation of benzyne, regioselectivity, Diazonium salt – reactions

Unit 3: Electrophilic Substitution and Elimination (10 Hours)

Aromatic electrophilic substitution – Arenium ion mechanism – alkylation, acylation, nitration, sulfonation, halogenation, Reimer Tiemann and VilsmeierHaack reaction, ortho/para, meta selectivity. Orientation in mono and di-substituted benzene rings –Electrophile addition to C-C-multiple bonds, Markovnikov rule.Epoxidation-Addition to 1,3-diene-Elimination – Mechanisms of β elimination – (E2, E1, E1CB) –Effect of substrate, attacking base, leaving group and medium, Saytzeff rule, Bredt's rule – Hoffman Elimination, 1,1-elimination and carbene generation, synelimination, Chugaev and Cope elimination

Unit 4: Stereochemistry (8 Hours)

Stereoisomerism – Definitions- enantiomer, diastereomer, geometrical isomer, epimer,anomer, chirality, optical rotation, specific rotation-problem.Enantiomeric excess – problem-Topicity-Enantiotopic, diastereotopic and homotopic-Inter conversion between Fischer, Newmann, Saw Horse and Wedge-dash projections-absolute ConfigurationCahn-Ingold-Prelog rule- R&S, E&Z– Axial chirality-atropisomerism-planar chirality and helicity. R&S configuration for biaryls, allenes, spiro compounds, cyclophanes

Unit 5: Conformation and Asymmetric Synthesis (9 Hours)

Conformation of ethane, butane, cyclohexane, decalin. Gauche effect,example. 1,3-diaxial interaction,stable conformer of mono, and disubstitutedcyclohexanes – Stereoselectivity and stereospecificity-Asymmetric synthesis-Cram's rule, Prelog's rule, Evan's chiral auxiliary in aldol reaction, Sharpless asymmetric epoxidation, Asymmetric dihydroxylation-ADH - kinetic resolution – Enzymatic and kinetic methods

Reference Books:

1. Jerry March, "Advanced Organic Chemistry", Wiley Eastern Limited, New Delhi, 4th edition, 2008.
2. Jonathan Clayden, Nick Greeves, Stuart Warren. "Organic Chemistry", 2nd edition, Oxford University Press, 2012
3. Bahl. B.S and ArunBahl, "A Text book of Organic Chemistry", S. Chand & company Ltd., New Delhi, Reprint, 2011.
4. Peter Sykes, "A Guidebook to Mechanism in Organic Chemistry", Longman Press, London and New York, Reprint, 2006.
5. Ernest. L. Eliel, "Stereochemistry of carbon compounds", Tata-McGraw Hill, New Delhi, 22nd Reprint 2009.
6. Nasipuri. D. "Stereochemistry of organic compounds – Principles and applications", New Age international, 2nd edition, 2002.
7. Kalsi. P.S. "Stereochemistry Conformation and Mechanism", New Age International Publishers, New Delhi, 6th Edition, Reprint, 2005.
8. Finar. I.L, "Organic Chemistry, Volume 1", Doorling Kindersley (Indian), 6th Edition, 5th impression, 2008.
9. Raj K. Bansal, "Organic reaction mechanism", Tata McGraw Hill, New Delhi, 4th Edition, 2005.
10. Carey. F.A. "Organic Chemistry", McGraw Hill, Inc., 2nd edition, 1992.
11. Morrison and Boyd, "Organic Chemistry", United States of America, 3rd edition, 1992.
12. Carey, F. A, and Sundberg, R. J, "Advanced Organic Chemistry Part – A", Plenum Press, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3	1					2	2	
CO2		2						2	2	
CO3	3				1			3	3	1
CO4				2			3	3	3	
CO5	1	3						1	2	1
CO6							1	1	2	1

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20CH3004	Statistical Thermodynamics and Quantum Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the principles of statistical thermodynamics
2. learn the importance of quantum chemistry
3. know the concept of quantum chemistry of bonding

Course Outcomes:

Student will be able to

1. relate various thermodynamic parameters
2. know about the applications of irreversible thermodynamics
3. understand the importance and application of quantization in molecular energy levels
4. explain the shape, energy of atomic orbitals and molecular orbitals and the bond formation between atoms
5. Know about LCAO, MO and VB treatments of hydrogen molecule
6. Understand the importance of Huckel theory of linear conjugated systems and cyclic systems

Unit 1: Statistical Thermodynamics – I (9 Hours)

Concepts of probability and Maxwell Boltzmann distribution – Basic derivation – prove that $\beta = 1/KT$ – Relationship between entropy and thermodynamic probability systems with degeneracy – Definitions of partition function – applications – derivation of thermodynamic functions from partition function – entropy for monoatomic gases – Sackur – Tetrode equation – The Bose – Einstein's system – Basic derivation – Fermi – Dirac system – Basic derivation – negative Kelvin temperature.

Unit 2: Statistical Thermodynamics – II (9 Hours)

Heat capacity of solids – Debye and Einstein models – Thermodynamics functions of ideal gases, translational, vibrational and rotational contributions at different levels of approximation – Irreversible thermodynamics – the steady – coupled flows – application – over potential – decomposition potential – electrical double layer and electro kinetic phenomena – structure of electrical double layer – capacity – E.K. phenomenon – steaming potential – electro dialysis – the Dorn effect.

Unit 3: Introduction to Quantum Mechanics (9 Hours)

The failures of classical mecahnism – heat capacities – black body radiation – The photo electric effect – The Compton effect – The diffraction of electrons – wave particles duality- de Broglie Equation- Problems – Hydrogen spectrum- Uncertainty principle, Problems, operators and commutation relations – Postulates of quantum mechanics.

Unit 4: Quantum Chemistry of Atoms and Molecules(9 Hours)

Scrondinger equation-derivation, Free particle, particle in one dimensional box, three dimensional box Harmonic oscillator, – Rigid rotor – The Schrodinger equation for hydrogen atom – Angular momentum – Spin, coupling of angular momentum – Spin-orbit coupling. Variation and perturbation theory – Application of perturbation / variation theorems to ground state of helium atom.

Unit 5: Quantum Chemistry of Bonding (9 Hours)

Antisymmetry and Pauli's exclusion principle – Aufbau principle – Slater detrimental wave functions – Term symbols and spectroscopic states – Born Oppenheimer approximation –Linear Combination of atomic orbitals (LCAO), MO and VB treatments of hydrogen molecule – Hybridization – Huckel theory of linear conjugated systems ethylene, butadiene – Cyclic systems -cyclobutene – Wood- ward Hoffman rules.

Text books:

1. N.D. Smith, "Elementary Statistical Thermodynamics", Plenum Press, New York, 1982.
2. Donald A McQuarrie, "Quantum Chemistry", University Science Books, Mill Valley, California, 1983.
3. Chandra, A.K. "Quantum Chemistry" Tata McGraw –Hill Pvt. Ltd., New Delhi, 4th Edition, 2002.
4. Hanna, M.W., "Quantum Mechanics in Chemistry", Addition Wisley, London, 3rd edition, 1981.
5. John C. Schug, "Introductory Quantum Chemistry", Holt, R & W Publisher, 1972

Reference Books:

1. S. Glasstone and D.Lewis, "Elements of Physical Chemistry", 2nd Ed.,1982.
2. B.C. McClelland, "Statistical Thermodynamics", Chapman and Hall, London, 1973.
3. M. C. Gupta, "Statistical Thermodynamics", Wiley Eastern Limited, 1993.
4. L.K. Nash, "Elements of classical the statistical thermodynamics", Addision-Wesley (1970)
5. I.N. Levine, "Quantum Chemistry", 4th edition, Prentice Hall India, 1994

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	-	1	1	-	1	2	1	2
CO2	1	2	1	1	2	1	1	1	2	1
CO3	1	-	-	1	-	1	1	1	1	3
CO4	1	1	1	1	1	1	1	1	1	1
CO5	1	1	-	-	-	1	1	1	1	1
CO6	1	1	-	-	-	1	1	1	1	1

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3005	Coordination Chemistry of Transition Elements	L 3	T 0	P 0	C 3

Course Objectives:

Enable the student to

1. characterize the electronic spectra and magnetic properties of coordination complexes
2. explain the isomerism and stability of coordination complexes
3. discuss the reaction mechanism in coordination Chemistry

Course Outcomes:

Student will be able to

1. characterize the electronic spectra of metal complexes

2. predict the magnetic properties of coordination complexes
3. discuss the isomerism in coordination complexes
4. summarize the factors affecting the stability of metal complexes
5. categorize the types of mechanisms in reactions of metal complexes
6. describe the importance of metal-metal multiple bonds

Unit 1: Electronic and Magnetic Properties (12 Hours)

Electronic Spectra — Types of Transitions - Term Symbols – Spin-Spin and Spin-orbit Coupling - Ground Terms for d Configuration, - Problems -Terms Generated in Ligand FieldsCorrelation Diagrams, - Orgel Diagram – Nephelauxetic Ratio - Racah Parameter -Tanabe Sugano Diagram – Selection Rules for Electronic Transitions - Width of the spectra, Jahn-Teller Effect – Electronic Spectra of d^n Complexes - CT Spectra –Types - Magnetic Properties – Magnetic moment - Determination of Magnetic Susceptibility - Orbital Contribution to Magnetic Moment – Quenching

Unit 2: Isomerism and Stability of Coordination Complexes (9 Hours)

Isomerism - Structural Isomerism – Stereoisomerism – D and L isomers – Cotton effect -Stepwise and Overall Stability Constant - Irwing William Series - Factors Affecting the Stability Constant - Chelate and Macrocyclic Effects – Determination of Stability Constant Problems

Unit 3: Substitution Reactions in Coordination Complexes (12 Hours)

Thermodynamic and Kinetic Stability - Labile and Inert Complexes - Substitution in Octahedral Complexes – Rate constants for water exchange reactions - S_N1, S_N2 and $S_N1(CB)$ Mechanism - Isomerization Reactions, Anation Reactions - Reactions of Coordinated Ligands - Substitution in square Planar Complexes – Trans Effect – Series - Applications of Trans Effect - Theories of Trans Effect

Unit 4: Electron Transfer Reactions in Coordination Complexes (6 Hours)

Electron transfer reactions – Complementary and noncomplementary reactions - Types - Outer sphere electron transfer reaction - Marcus Theory - Innersphere Reactions —Nature of Bridging Ligand - Applications

Unit 5: Compounds with metal-metal multiple bonds (6 Hours)

The origin of σ, π, and δ interactions between the d orbitals– Electronic spectra -Tetracarboxylate and halogen complexes of Molybdenum, Tungsten, Rhodium and Rhenium complexes - Applications

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Purcell K. F & Kotz J. C., "Inorganic Chemistry" Cengage Learning, New Delhi, India, Reprint, 2010.
3. Greenwood N. N. & Earnshaw A, "Chemistry of the Elements", Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
4. Miessler G. L & Tarr D. A., "Inorganic Chemistry", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 3rd Edition, 2009.
5. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
6. Cotton F. A & Wilkinson G, "Advanced Inorganic Chemistry", 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
7. Jordan R. B, "Reaction Mechanisms of Inorganic and Organometallic Systems", Oxford University Press, New York, USA, 3rd Edition, 2007.
8. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, "Advanced Inorganic Chemistry" Vol I and II, S. Chand and Company Ltd, NewDelhi, India, Reprint: 2009.
9. Shriver and Atkins, " Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
10. Figgis B. N. & Hitchman M. A, "Ligand Field Theory and Its Applications", Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2000.
11. Cotton FA, Murillo CA, Walton RA "Multiple Bonds Between Metal Atoms", Springer, New York, 3rd Ed, *(*2005*)*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1						1	2	
CO2	3	2						1	2	

CO3		1		2				2	3	
CO4		1							3	1
CO5	2				1			1	2	
CO6			1	1					1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3006	Principles of Molecular Spectroscopy	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Discuss the electromagnetic spectrum and electromagnetic radiation
2. Explain the principle and application Vibration and Raman spectroscopy
3. Relate the principle and application NMR, ESR, Mossbauer, PES and fluorescence spectroscopy

Course Outcomes:

Student will be able to

1. Discuss the principle and application of microwave spectroscopy
2. Relate the principle and application of microwave spectroscopy
3. understand the principle and application of Vibration and Raman spectroscopy
4. Show the principle and application of NMR and ESR in organic and inorganic sample analysis
5. Examine the principle and application of Mossbauer and PES in material analysis
6. Explain the principle and application of electronic and emission spectroscopy. in material analysis

Unit 1: Electronic and Rotational Spectroscopy (9 Hours)

Introduction to electromagnetic radiation- Regions of the spectrum, characterization of electromagnetic radiation, Born-Oppenheimer approximation, Electronic spectra of Diatomic Molecules- linear combination of atomic orbitals (LCAO), Molecular term symbols, selection rules for electronic spectra, Franck-condon principle. Electronic Spectra of polyatomic molecules.Introduction to rotational spectroscopy, rotational spectra diatomic molecules – the rigid diatomic molecule, selection rules for rotational spectra, Effect of isotopic substitution, the non-rigid rotator, Polyatomic molecules- Linear molecules, Techniques and instrumentation and chemical analysis by microwave spectroscopy,

Unit 2: Vibration and Raman spectroscopy (9 Hours)

Introduction, simple harmonic oscillator, Anharmonic oscillator, Infrared spectroscopy of di- and polyatomic molecules-carbon monoxide, fundamental vibrations of polyatomic molecules and their symmetry, Overtone, combination of bands, Fermi resonance, factors affecting vibrational frequencies, Instrumentation and Applications. Raman spectroscopy- introduction, Raman effect-molecular polarizability, Polarization of light and the Raman effect, Pure rotational raman spectra- linear, symmetric top and asymmetric top molecules, Vibrational raman spectra, Mutual exclusion principle, instrumentation and application of Raman spectroscopy.

Unit 3: NMR and ESR spectrometry (9 Hours)

NMR spectroscopy- introduction, Nuclear magnetic resonance phenomenon, The absorption process, Relaxation process- spin spin relaxation, Spin lattice relaxation, Chemical shift, factors influencing chemical shift, NMR spectra of AX, A_3X and AB systems. ESR spectroscopy – introduction, g factor, Spectra of simple organic radicals, Spectra of first row transition metals, Zero field splitting, Kramer's degeneracy

Unit 4: Mossbauer and Photoelectron Spectroscopy (9 Hours)

Mossbauer spectroscopy- introduction, principle, Isomer shift, Quadrupoleeffects,Hyperfine splitting, Applications of Mossbauer spectroscopy. Photoelectron spectroscopy (PES)-PrinciplePhotoelectron spectroscopy (PES)- instrumentation, Ultraviolet Photo electron spectroscopy (UPS)X- Ray Photo electron spectroscopy (XPS) Auger electron spectroscopy

Unit 5: Flourescence spectroscopy (9 Hours)

Flourescence spectroscopy- introduction, principle, instrumentation, Jablonski diagram, Fluorescence, Phosphorescence, Delayed fluorescence, Characteristics of Fluorescence emission, Fluorescence Lifetimes and quantum yields, Fluorescence Quenching, Resonance energy transfer (RET), Steady state and time resolved Fluorescence.

Reference Books :

1. Banwell, C. N, "Fundamentals of Molecular Spectroscopy", 4th Edition, Tata McGraw-Hill India Ltd, 2010
2. Molecular Spectroscopy. I. N. Levine, Wiley Interscience Publication.
3. Drago R. S, Physical Methods for Chemists, 2nd Revised edition,n Saunders (W.B.) Co Ltd;
4. Molecular Spectra & Molecular Structure. G. Herzberg, Van Nostrand Reinhold Company
5. SatyaNarayana D. N, "Vibrational Spectroscopy Theory and Applications", New Age International Publishers, New Delhi, 2004.
6. SatyaNarayana D. N, "Electronic Absorption Spectroscopy and Related Techniques", Universities Press (India) Ltd, Hyderabad, 2001.
7. Lakowicz J. R, "Principles of fluorescence spectroscopy", Springer Science+Business Media, New York, USA, 3rd editon, 2006.
8. Principles of Ultraviolet Photoelectron Spectroscopy, J. W. Rabalais, John Wiley & Sons.
9. SatyaNarayana D.N., "Magnetic Resonance Spectroscopy ESR, NMR, NQR", I. K. International, New Delhi, 2009
10. Graybeal J. D., Molecular Spectroscopy.,McGraw Hill.
11. Hollas J. M., Modern Spectroscopy. John Wiley & Sons.

20CH3007	Synthetic Reagents and Methodology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. acquire skills on metal catalyzed coupling reactions
2. realize the potential of various reagents used in organic transformations
3. understand the molecular rearrangement and apply retro synthesis to target molecule

Course Outcomes:

Student will be able to

1. explain the importance of metal catalyzed coupling reactions in synthesis
2. summarize the reagents used for oxidation and reduction reactions
3. apply modern synthetic reagents in organic synthesis
4. describe the usefulness of multi component coupling in synthesis
5. predict the product formed in molecular rearrangements
6. apply retrosynthetic approach to complex target molecules

Unit 1: Organometallics in Coupling Reactions (8 Hours)

coupling reactions-definition, Organometallic reactions-oxidative addition , insertion - reductive elimination, Heck reaction, catalytic cycle, Suzuki Coupling,stereospecificity- aryl and vinyl boron compound synthesis-Stille Coupling, Negishi coupling- Buchwald amination, Sonogashira coupling-Glacier coupling- pi-allyl complex-Tsuji Trost reaction –Regio and stereoselectivity,Ullmann reaction, catalytic cycles.

Unit 2: Reagents for Oxidation and Reduction (10 Hours)

DMSO based oxidation- Swern, Corey Kim, Moffatt-Pfitzner- Metal oxide oxidants- PCC, PDC, Jones reagent, MnO_2, $KMnO_4$, TPAP- Hypervalent iodine- IBX, Dess-Martin periodinane, Oppeneur oxidation. Reduction – Metal hydrides- $NaBH_4$, LAH, DIBAL-H, $NaCNBH_3$, $LIBH_4$, BH_3, Selectride, Li/liq.NH_3 reduction of aromatic ring, alkyne, cyclohexenone, Bouvelt-Blanc reduction, Raney/Ni, Pd/C, H_2-MPV reduction

Unit 3: Modern Synthetic Reagents and Multicomponent Reaction (9 Hours)

Modern Synthetic Reagents : NBS- DDQ- DCC,R_2CuLi, Gilmann Reagent, Wittig salt, Wittig-Horner reaction, trimethylsulfonium and sulfoxoniumylide- Corey-Chaykovsky reaction, Tebbe reagent,mCPBA, CH_2I_2 and Zn/Cu-Simmons Smith–diazomethane-SeO_2, multicomponent reactions, Strecker'samino acid synthesis, Ugireaction, Passerini reaction, Biginelli reaction, mechanism.

Unit 4: Molecular Rearrangement (10 Hours)

1,2-shift to electrophilic carbon – Wagner –Meerwin, Pinacol-Pinacolone, Benzil-Benzilic acid rearrangement- Favorski- Dieneone phenol- Wolf rearrangement-Demjanov – 1,2-shift to electrophilic Oxygen – Baeyer Villiger Oxidation, Dakin reaction- hydroboration oxidation -1,2-shift to electrophilic

nitrogen –Curtius - Schimidt – Hoffmann – Lossen rearrangements, Beckmann rearrangement – Sommelet Hauser-Benzidine rearrangement-Neber rearrangement

Unit 5: Reterosynthesis – The Disconnection Approach (8 Hours)

Synthons and reagents – Strategy I: The order of events – one group disconnection – Strategy II: Chemoselectivity – Two group Disconnection – Strategy III; Reversal of polarity, 1,3-dithiane and cyclization – Strategy IV: protecting groups – Strategy V: Stereoselectivity – Strategy VI: Carbonyl condensation - Strategy VII: Aliphatic nitro compounds – Strategy VIII: Ring synthesis.

Reference Books:

1. Smith M. B., Organic Synthesis, 3rd Edition, Wave Functions Inc. 2010.
2. Jonathan Clayden, Nick Greeves, Stuart Warren. "Organic Chemistry" 2nd edition, Oxford University Press, 2012
3. Jerry March, "Advanced Organic Chemistry", Wiley Eastern Limited, New Delhi, 4th edition, 2008.
4. Carruthers, W.; Coldham, I. Modern Methods of Organic Synthesis, 04th Edition Cambride University Press, 2004.
5. Joule, J. A. and Mills K. Heterocyclic Chemistry, 05th Edition, Wiley, 2010.
6. Agarwal. O.P, "Chemistry of natural products, Vol.1 & 2", Goel publishing house, 36th Edition, 2009.
7. Organic Chemistry (5thEdn.) Robert. T.Morrison& N. Boyd. Hill edition.
8. Stuart Warren, "Organic Synthesis – The disconnection approach" – A John Wiley and Sons, Ltd., 2nd Edition, reprint, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	2					2	2	2	1
CO2					3		1	2	2	
CO3	1			3				2	3	1
CO4		2			1			2		1
CO5			2			1		2	1	
CO6					2		3	2	3	1

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20CH3008	Group Theory and Applied Physical Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the concepts of group theory to atoms and molecules.
2. learn the importance of surface chemistry and solids
3. know the fundamentals of photochemistry and electrochemistry

Course Outcomes:

Student will be able to

1. appreciate the symmetry in molecules and in nature
2. able to identify and group the objects or molecules of same category based on the symmetry elements
3. distinguish different isotherms
4. recognize the importance of photosensitization of chemiluminescence
5. understand the basic principles of electrochemistry
6. Know about electrokinetics

Unit 1: Group Theory (9 Hours)

Molecular symmetry – symmetry elements and symmetry operations-successive operations, inverse operations - Cartesian coordinate system - relations among symmetry elements - Properties of a group – Abelian, non abelian and Isomorphic groups - Multiplication tables – classes, subgroups - Molecular point groups - Schoenflies symbols - Matrices of symmetry operations - Representations of a group-Reducible and irreducible, representations - Statement and proof of Great orthogonality theorem - Characters and construction of character table (C2v, C3v) – Explanation of a character table - Direct product groups.

Unit 2: Applications of Group Theory (9 Hours)

Standard reduction formula relating reducible and irreducible representations -Symmetries of normal modes of vibration in non-linear molecules (H_2O, NH_3, BF_3) - Selection rules for vibrational spectra – IR and Raman active fundamentals – Mutual exclusion rule - Symmetries of M.O and symmetry selection rule for electronic transition in ethylene and formaldehyde - Hybridization schemes for atoms in methane, ethylene and butadiene.

Unit 3: Surface Chemistry & Colloids (9 Hours)

Adsorption – Difference between adsorption and absorption – Classification of adsorption – Physisorption – Chemisorption – Adsorption isotherm – Freundlisch's adsorption isotherm – Applications of adsorption – Types of solutions – Types of colloidal solutions – Preparation of colloidal solutions – Condensation methods – Disintegration methods – Purification of colloidal solutions – Dialysis – Ultrafiltration – Characteristics of colloidal solutions – Emulsions – Micelles.

Unit 4: Photochemistry (9 Hours)

Absorption and emission of radiation – Theories – Spontaneous and induced emission –Laser – Franck Condon principle - Type 1 & 2 – Physical properties of electronic excited state – Emission – Resonance emission – Selection rule – Fluorescence – Phosphorescence – Delayed fluorescence: E-Type and P-Type – Excimer and Exciplex complex formation – Photosensitization and Chemiluminescence – Experimental techniques – Actinometry – Chemical actinometry – Flash photolysis.

Unit 5: Electrochemistry (9 Hours)

Conductance - transport number - Debye- Huckel- Onsager equation- Falkenhagen effect, Wien effect - ionic strength, Debye-Huckel limiting law and its verifications - electrode potential - concentration cells - liquid junction potential - Electro kinetic phenomena: Theories of double layer - Helmoltz-Perrin, Gouy-Chapmann & Stern theories - elecrodics - mechanism of electrode reactions - polarization and over potential - Butler-Volmer equation - electrophoresis and electro osmosis.

Text books:

1. S. Swarnalakshmi, "A Simple Approach to Group Theory in Chemistry" Universities Press, 2009.
2. K.V. Raman, "Group theory and its applications to chemistry", Tata Mac Graw Hill, 2004.
3. A.W. Adamson, "Physical Chemistry of Surfaces", Wiley, 6th edition, 1997.
4. K. K. Rohatgi Mukherjee "Fundamentals of photochemistry", New Age International Pvt. Ltd., New Delhi, 2009.
5. John O'M. Bockris, Amulya K. N. Reddy, "Modern Electrochemistry Vol. I and II", Plenum Publishing, 1970.

Reference Books:

1. Cotton F.A. "Chemical application of group theory", Wiley India Pvt. Ltd., New Delhi, India, 3rd edition, 2009.
2. Carter R.L., Molecular Symmetry and Group Theory, John Wiley & Sons, NY, 2005.
3. Atkins P.W., "Physical Chemistry", Oxford University Press, 8th edition, 2006.
4. Glasstone, "An Introduction to Electrochemistry Van Nostrand Co. Inc., Newyork, 1943.
5. Richard C. Alkire, Dieter M. Kolb, Jacek Lipkowski and Phil Ross, "Advances in Electrochemical Science and Engineering, Volume 9, Wiley, 2006.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	-	-	-	1	1	1	-	1	1	1
CO2	1	1	1	1	1	1	1	1	1	2
CO3	-	-	-	-	1	2	1	1	2	1
CO4	1	2	2	1	1	2	3	1	2	3
CO5	1	1	1	2	1	1	1	1	2	3
CO6	1	1	1	2	1	2	1	1	2	2

"3"– High; "2"– Medium; "1"– - Low; "-"– No correlation

20CH3009	Organometallic and Bioinorganic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. summarize the applications of organometallic chemistry

2. discuss the role of metals in biological chemistry
3. apply the concept of inorganic photochemistry

Course Outcomes :

Student will be able to

1. apply the 18 electron rule
2. describe the structure of various types of transition metal organometallic complexes
3. utilize the reactions of organometallic complexes
4. practice the applications of organometallic complexes in catalysis
5. discuss the role of metals in biology
6. identify the metal complexes that can be used for solar energy conversion

Unit 1: Organometallic Chemistry – Structure (14 Hours)

18 Electron Rule - MO theory and 18 electron rule – Electron Counting - Problems - Metal carbonyl complexes - Preparation and Properties - Polynuclear metal carbonyls - Carbonylate anions - Carbonyl Hydride Complexes - Structure prediction for organometallic cluster - Metal Nitrosyl Complexes - Metal nitrogen complexes - Alkyl complexes - Chemistry of Metal carbene and Carbyne complexes - Alkene and Alkyne complexes - Allyl and Arene complexes - Metallocenes

Unit 2: Reactions In Organometallic Chemistry (6 Hours)

Reactions – Types – Ligand Cone angle – Oxidative addition - Reductive elimination – Insertion – Migration - Nucleophilic and electrophilic attack on coordinated ligands - Carbonylate anions as nucleophiile- Fluxionality

Unit 3: Catalysis (6 Hours)

Catalysis – Tolman loop – Hydrogenation - Carbonylation - Hydroformylation - Wacker Process - Zeigler-Natta Catalysis

Unit 4: Biological Inorganic Chemistry (12 Hours)

Essential and Trace elements in Biological Systems – Bioinorganic Chemistry of Fe, Co, Cu, Mn and Zn – Metalloporphyrin and Heme - Fe- Oxygen Bindng – Structure and functions of hemoglobin – Myoglobin - physiology of O2 binding - Electron transport – Ferridoxin, rubridoxin - Blue – Copper Proteins – Photosynthesis - Chlorophyll - Enzymes – Model Complexes - Carboxy peptidase - Carbonic anhydrase - Nitrogen Fixation – Hydrogenase - Vitamin B12 and B12 coenzymes – Model complexes - Platinum anticancer drugs – Biomaterials

Unit 5: Inorganic Photochemistry (7 Hours)

Properties of excited states - Basic Photochemical Processes – Energy transfer – Charge transfer photochemistry – Photodissociation - Photosubstitution reactions – photoisomerization - Photoredox reactions — Ruthenium Polypyridine complexes – Uses

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
1. Shriver and Atkins, “ Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
2. Porterfield W. W, “Inorganic Chemistry A Unified Approach”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd Edition, Reprinted 2009.
3. Purcell K. F & Kotz J. C., “Inorganic Chemistry” Cengage Learning, New Delhi, India, Reprint, 2010.
4. Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
5. Gupta B. D & Elias A. J, “Basic Organometallic Chemistry”, CRC Press, New Delhi, India, 2010.
6. Greenwood N. N. & Earnshaw A, “Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
7. K. Hussain Reddy, BIOINORGANIC CHEMISTRY, New Age International Ltd, 2003
8. Bertini I, Gray H. B, Lippard S. J & Valentine J. S, “Bioinorganic Chemistry”, Viva Books Private Ltd, New Delhi, India, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1	2	2				1	2	
CO2	3	2	2					1	2	
CO3		1		2				2	3	
CO4		3	2		1				3	1
CO5	3				1			1	2	
CO6	2	1	2		1				1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3010	Pericyclic Reactions and Biomolecules	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the fundamental principles of pericyclic and photochemical reactions
2. acquire knowledge on the synthesis and reactions of heterocyclic compounds
3. realize the importance of biomolecules in the functioning of living system

Course Outcomes:

Student will be able to

1. apply the principles and applications of pericyclic reactions to predict the product.
2. reason out for the product formed in the photochemical reaction
3. describe the synthesis of heterocycles molecules from suitable precursors
4. summarize the properties and applications of heterocyclic compounds
5. elaborate the extraction and structural elucidation of natural products
6. explain the structure and role of biomolecules in living system

Unit 1: Pericyclic Reactions (9 Hours)

Pericyclic reaction-definition and types- Electrocyclic ring closing and ring opening-conrotatory and disrotatory, FMO method, correlation diagram- Woodward-Hoffmann rule –Nazarov cyclization,Cycloaddition - FMO method, correlation diagram- Woodward-Hoffmann rule, selectivity-Diels Alder- endo, regio and stereoselectivity – Sigmatropic rearrangement – [3,3], Cope, oxy-cope, Claisen, Johnson-claisen, Ireland-claisen, stereochemistry of sigmatropic reaction, [2,3] sigmatropic reactions-, ene reaction- stereochemistry, chelotropic reactions

Unit 2: Photochemical Reactions (9 Hours)

Reactivity of Electronically excited ketones Norrish Type I, Type II reactions – Photoreduction and oxidation – Paterno-Buchi reaction - Photo rearrangements – Photo Fries rearrangement, di-pi-methane and oxa-di-pi-methane rearrangement, Lumiketone rearrangement, Remote functionalization Barton and Hoffmann-Loftler-Freytag reaction, cis-trans isomerization photostationary state

Unit 3: Heterocyclic Chemistry (8 Hours)

Introduction and Nomenclature, Imidazole synthesis, properties, ionic liquid, N-heterocyclic carbene, pyrazole, synthesis, reactions, indole, Fischer-indole synthesis, Madelung synthesis, Bischler and Reissert synthesis, properties, Synthesis and properties of Pyridazine, Pyrimidine.

Unit 4: Natural products - structural elucidation and synthesis (9 Hours)

Natural products-extraction, Soxhlet extraction, Index of hydrogen deficiency, Empirical formula from CHN- Physical and chemical methods for the structure elucidation of alkaloids, Terpenoids, steroids. Synthesis of menthol, Nicotine, Cholesterol.

Unit 5:Chemistry of Biomolecules (10 Hours)

Structure and functions of Vitamins, structure and reactions of carbohydrates, mutarotation- oxidation, reduction, osazone formation, Diol cleavage, Fischer-Kiliani homologation and Ruff degradation, anomeric effect, Structure and types of Amino acids, isoelectric point, peptide synthesis, Merrifield resin-proteins and enzymes, Edman degradation and Sangers method. Primary, secondary, tertiary and quaternary structure of DNA and RNA.

Reference Books:

1. Jagadamba Singh and Jaya Singh, "Photochemistry and Pericyclic Reactions", New Age International Publishers, New Delhi, 3rd Revised Edition, Reprint, 2011.
2. Finar. I. L, "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 2008.

3. Raj.K. Bansal, "Heterocyclic Chemistry", New Age International Publishers, 4th Edition, Reprint, 2009.
4. Finar. I.L., "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 5th Impression 2008.
5. *Gurdeep R. Chatwal, "Organic Chemistry of Natural Products", Himalaya Publishing Home, New Delhi, 5th & Enlarged Edition, 2008.*
6. Lehninger" Principles of Biochemistry" 5th edition, 2008 - Nelson, D. L. and M. M. Cox. (W. H. Freeman &Co.).
7. Carey, F. A., Sundberg. R. J, "Advanced Organic Chemistry Part – B: Reactions and Synthesis", Plenum Press, 2008.
8. Gurdeep R. Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", Himalaya Publishing House, New Delhi, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3			1			2	1	
CO2	1	2						3		
CO3		2			2			2	1	
CO4		3		2			2	2	3	1
CO5						2	3	2	3	1
CO6		2					3	2		1

"3"– High; "2"– Medium; "1"– - Low; "-"– No correlation

20CH3011	Qualitative and Quantitative Organic Analysis Lab	L	T	P	C
		0	0	6	4

Course Objectives:

Enable the student to

1. Identify the functional group of the organic compound by qualitative analysis
2. Carryout various types of organic reactions to analyse the organic compound
3. Understand the principle and estimate organic compound quantitatively

Course Outcomes:

Student will be able to

1. Carry out systematic analysis of an organic compound
2. Understand the mechanism of the various reactions.
3. Recognize the importance of analysing organic compound
4. Employ various types of organic reaction in synthesis
5. Apply the knowledge in analysing real samples
6. Prepare derivatives for the given organic compound

List of experiments

1. Qualitative analysis of organic mixture-I
2. Qualitative analysis of organic mixture-II
3. Qualitative analysis of organic mixture-III
4. Qualitative analysis of organic mixture-IV
5. Qualitative analysis of organic mixture-V
6. Qualitative analysis of organic mixture-VI
7. Qualitative analysis of organic mixture-VII
8. Qualitative analysis of organic mixture-VIII
9. Estimation of Phenol
10. Estimation of Aniline
11. Estimation of Ascorbic acid
12. Estimation of Glucose

(Minimum 10 experiments to be conducted)

Reference Books:

1. A.I. Vogel – "Text book of practical organic chemistry", 5th Ed. ELBS, London, 1989

2. B.B. Dey and M.V. Sitharaman, "Laboratory manual of Organic Chemistry" Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, "Experimental Organic Chemistry" John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, "Text book of Practical Organic Chemistry", LBS, Singapore, 1994
5. S.M. Khopar, "Basic concepts of Analytical Chemistry", John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, "Organic Chemistry Lab Manual", revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		2	3	1
CO2		3						1	1	
CO3	1	2			3		2	2	2	2
CO4					1	3	2	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

20CH3012	Qualitative Analysis and Inorganic Preparation Lab	L	T	P	C
		0	0	6	4

Course Objectives:

Enable the student to

1. learn about the methods used in qualitative inorganic analysis containing common and less common ions
2. synthesize the metal complexes
3. characterize the metal complexes using spectroscopic techniques

Course Outcomes :

Student will be able to

1. Perform semimicro analysis
2. classify the ions into various groups
3. differentiate between common and less common ions
4. practice complex preparation techniques.
5. understand the mechanism of the various preparative synthetic steps.
6. characterize the inorganic complexes by spectroscopic techniques

Course Description :

1. Semimicro qualitative inorganic analysis-I
2. Semimicro qualitative inorganic analysis -II
3. Semimicro qualitative inorganic analysis -III
4. Semimicro qualitative inorganic analysis -IV
5. Semimicro qualitative inorganic analysis -V
6. Semimicro qualitative inorganic analysis -VI
7. Semimicro qualitative inorganic analysis -VII
8. Semimicro qualitative inorganic analysis –VIII
9. Semimicro qualitative inorganic analysis –IX
10. Semimicro qualitative inorganic analysis –X
11. Preparation of Potassium trioxalato ferrate(III) trihydrate
12. Preparation of Hexathiourea Lead(II)nitrate
13. Preparation of Tetraamine copper (II) sulphate
14. Synthesis of hexaammine cobalt(III) chloride
15. Preparation of Diaquabis (ethylenediamine) copper (II) iodide
16. Preparation of Dichlorobis (ethylenediamine) cobalt(II) chloride
17. Preparation of Potassium trioxalato Chromium(III)
18. Solid phase synthesis of *trans*- bis glycinato copper (II):
19. Preparation of bis(N, N' disalicylalethylene-diamine)-μ- aquadicobalt(II)
20. Synthesis of pentaamminechlorocobalt(III) chloride

21. Preparation of Manganesedioxide nano-particles
22. Preparation of bis-chloro bis-triphenyl phosphine nickel (II)

(Minimum 10 experiments to be completed)

Reference Books :

3. Ramanujam V. V., "Inorganic semimicro qualitative analysis", 3rd edition, The national publishing company, Chennai, India, reprinted 2008.
4. Svehla G., "Vogel's Textbook of Qualititative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.
5. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
6. Allcock, H, R.,"Inorganic Syntheses", Volume 25, John Wiley & Sons, New York, USA, 1989

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	-	-	1	2	1
CO2	-	-	1	1	-			1	1	1
CO3	-	-	-	1	-			1	1	2
CO4	-	-	-	-	-			1	1	1
CO5	1	1	1	1	1			1	1	1
CO6	1	1	1	1	1			1	2	3

20CH3013	Physical Chemistry Lab	L	T	P	C
		0	0	6	4

Course Objectives:

Enable the student to

1. carryout chemical reaction which would be monitored by electroanalytical and other experimental studies
2. develop skills in the application area of electrochemical based experiments
3. learn the techniques used for kinetics

Course Outcomes:

Student will be able to

1. apply the physical chemistry concepts in chemical kinetics
2. handle the experiments like conductometry, spectrophotometry, potentiometry.
3. understand the importance of the velocity of the reaction, distribution properties and adsorption studies.
4. recognize the factors affecting the rate of the reactions
5. understand the importance of absorption studies.
6. apply the practical knowledge and its solving route.

Course Description:

1. Determination of strength of the mixture of acids
2. Determination of percentage purity of $AgNO_3$ solution conductometrically
3. Precipitation reaction between $BaCl_2$& $MgSO_4$ – Conductometry
4. Verification of Onsager equation
5. Verification of Ostwald's Dilution law
6. Precipitation Titration of KCl Vs $AgNO_3$ (Potentiometry)
7. Determination of dissociation constant of weak acid using quinhydrone electrode
8. Determination of strength of unknown KI solution by potentiometric method
9. Determination of pH of a given buffer by potentiometry
10. Precipitation titration ($AgNO_3$ Vs KCl + KI) – Potentiometry
11. Ester hydrolysis – Comparison of acid strength
12. Freundlich adsorption isotherm
13. Verification of the validity of Beer – Lambert's law and determination of the concentration of chromium present in the given $K_2Cr_2O_7$ by spectrophotometry
14. Determination of the strength of ferrous ion present in the given solution by potentiometric method.

(Minimum 10 experiments to be completed)

Reference Books:

1. Svehla G., "Vogel's Textbook of Qualititative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.
2. Anand A., Kumari R., "Physical Chemistry Laboratory Manual: An Interdisciplinary Approach", I K International Publishing House Pvt. Ltd, 2019.
3. Sinha S.K., "Physical Chemistry: A Laboratory Manual", Alpha Science International Ltd; 1st edition, 2014.
4. Gold, "Physical Chemistry Laboratory Manual", Primis; 2nd edition, 1998.
5. Athawale, V.D., Mathur, P., "Experimental Physical Chemistry", New Age International Publishers, 2001.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	1	1	1	2	1
CO2	-	-	1	1	-	1	1	1	1	1
CO3	-	-	-	1	-	-	1	1	1	2
CO4	-	-	-	-	-	1	1	1	1	1
CO5	1	1	1	1	1	-	1	1	1	1
CO6	1	1	1	1	1	1	1	1	2	3

"3"– High; "2"– Medium; "1"– - Low; "-"– No correlation

20CH3014	Inorganic Quantitative Analysis lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn about accurate and precise chemical analysis.
2. Perform various types of volumetric analysis
3. Practice gravimetric method of analysis

Course Outcomes:

Student will be able to

1. gain the laboratory skills
2. practice accurate measurement techniques
3. understand the importance of various types of volumetric analysis
4. learn the importance of precipitants
5. perform gravimetric method of analysis
6. estimate the elements in the mixture.

List of Experiments

1. 1.Volumetric Estimation of Zinc (Complexometry)
2. Volumetric Estimation of Calcium (Complexometry)
3. Volumetric Estimation of Nickel (Complexometry)
4. Volumetric Estimation of Aluminium (Complexometry)
5. Volumetric Estimation of Fe^{2+} - Internal indicator method
6. Volumetric Estimation of copper using thio (Iodometry)
7. Volumetric Estimation of Fe^{2+} (Permanaganometry)
8. Gravimetric Estimation of Nickel
9. Gravimetric Estimation of Barium
10. Gravimetric estimation of Copper
11. Gravimetric estimation of Magnesium
12. Quantitative estimation of copper (II) and calcium (II) from a mixture
13. Quantitative separation and determination Mg(II) (gravimetrically) and Ca(II) (Volumetrically)
14. Quantitative separation and determination of Ni(II) (gravimetrically) and Cu(II) (Volumetrically)
15. Quantitative separation and determination of Ba(II) (gravimetrically) and Cu(II) (Volumetrically)
16. Quantitative separation and determination of Fe(III) (gravimetrically) and Ca(II) (Volumetrically)

(Minimum 10 experiments to be completed)

Reference Books :

1. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008
2. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.

	PO 1	PO2	PO 3	PO4	PO5	PO 6	PO7	PSO 1	PSO 2	PSO 3
CO1	1	2	3	1	3			1	2	
CO2	3	1	2	3		1		1		
CO3				3	1					
CO4		1		3	2			1	1	
CO5			1		1	3		1	2	
CO6				3	2				3	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3015	Modern Instrumental Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand theory, instrumentation, and applications of separation techniques
2. analyze the sample using , Spectroscopic techniques.
3. understand theory, instrumentation, and applications of surface characaterization techniques

Course Outcomes:

Student will be able to

1. handle various analytical techniques
2. describe physical and chemical principles involved in instrumental analysis and practical skills
3. understand the principles of data acquisition and data analyses.
4. interpret analytical data and communicate the information about identification of different materials.
5. solve quantitative analytical problems.
6. choose the instrument for specific characterization

List of experiments

1. Demonstration of IR Spectrometer Instrument
2. IR spectral Analysis of Sample -I
3. IR spectral Analysis of Sample -II
4. IR spectral Analysis of Sample -III
5. Demonstration of UV-Visible Spectrometer
6. UV-Visible spectral Analysis of Sample -I
7. UV-Visible spectral Analysis of Sample -I
8. UV-Visible spectral Analysis of Sample -I
9. Separation of compounds using Thin Layer Chromatography of Sample -I
10. Separation of compounds using Thin Layer Chromatography of Sample -II
11. Separation of compounds using Thin Layer Chromatography of Sample -III
12. Separation of compounds using Column Chromatography –I
13. Separation of compounds using Column Chromatography –II
14. Analysis of Surface Morphology of metal oxide by Scanning Electron Microscopy - I
15. Analysis of Surface Morphology of metal oxide by Scanning Electron Microscopy - II
16. Analysis of Powder XRD Data- I
17. Analysis of Powder XRD Data- II
18. Demonstration of HPLC instrument

(Minimum 10 experiments to be completed)

Reference Book

1. Mendham J., Denny R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.

20CH3016	Synthetic Organic Chemistry Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Develop skills to prepare various organic compounds.
2. Learn the techniques in organic preparation.
3. Understand the purification techniques to get pure organic compound.

Course Outcomes:

Student will be able to

1. Design and prepare organic compounds in one step.
2. Purify the prepared organic compound and check the purity.
3. Setup the apparatus for various preparative techniques.
4. Understand the mechanism of various synthetic methods.
5. Recognize the importance of distillation, refluxing and recrystallization techniques.
6. Employ various types of reaction to prepare organic compound.

List of experiments

1. Preparation of Acetanilide from aniline
2. Preparation of acetyl salicylic acid from salicylic acid
3. Preparation of 2,4,6-tribromo aniline from aniline
4. Preparation of p-bromo acetanilide from acetanilide
5. Preparation of picric acid from phenol
6. Preparation ofbenzanilide from aniline
7. Preparation of Benzoic acid from benzoic acid
8. Preparation of p-nitro benzoic acid from 4-nitro toluene
9. Preparation of m-nitrophenol from m-nitroaniline
10. Preparation of fluorescein

(Minimum 10 experiments to be completed)

Reference Books:

1. A. I. Vogel – "Text book of practical organic chemistry", 5th Ed. ELBS, London, 1989
2. B. B. Dey and M.V. Sitharaman, "Laboratory manual of Organic Chemistry" Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, "Experimental Organic Chemistry" John Wiley & Sons, Inc., New York, 2000
4. B. S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, "Text book of Practical Organic Chemistry", LBS, Singapore, 1994
5. S. M. Khopar, "Basic concepts of Analytical Chemistry", John Wiley & Sons, 1984

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		2				3	1	2	3
CO2	2	1		3			2	3	2	1
CO3	2			3			1	2	1	3
CO4		3						3	1	1
CO5				2		3	1	3	3	3
CO6		1			2	3		3	2	3

20CH3017	Instrumental Methods of Chemical Analysis	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. develop sufficient knowledge about the physical/chemical basis of measurement
2. obtain knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixtures

3. understand the applications and analysis of various instrumental techniques

Course Outcomes:

Student will be able to

1. understand the range and theories of instrumental methods available in analytical chemistry
2. select the appropriate instruments for analyzing complex mixtures
3. choose the proper separation technique
4. know the importance of thermal methods of analysis
5. analyze the sample using microscopic techniques
6. recognize the importance of instrumentation techniques in paint, glass, paper, water, food, body fluid analysis.

Unit 1. Data Analysis (9 Hours)

Errors in chemical analysis – Mean, Median, Mode, Accuracy and Precision –Absolute and Relative Error; Determinate errors and Indeterminate errors. Improving accuracy of analysis mean, standard deviation absolute and relative errors; Covariance and coefficient correlation; significant figures and Q-test – Modern Instrumental Techniques – Classification – Examples.

Unit 2. Analytical Chromatography (9 Hours)

Classification – techniques and applications in column, Ion exchange, Paper and Thin layer chromatography. Gas chromatography and high performance liquid chromatography (HPLC) – principle, Instrumentation and application.

Unit 3. Thermal Methods of Analysis (9 Hours)

Thermal Characterization techniques Principle and applications of Differential Thermal Analysis (DTA), Differentials Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration - Theory – Instrumentation – Applications.

Unit 4. Microscopy methods of Analysis (9 Hours)

Atomic absorption Spectroscopy - Instrumentation – Applications - X-ray Methods – Instrumentation – – Diffraction pattern –- Applications – Crystal Tonograpy - Surface Characterization Techniques – SEM – TEM – instrumentation – Applications

Unit 5. Chemical analysis in Chemical Industries (9 Hours)

Paint analysis – Glass Analysis – Paper and Pulp Analysis - Water analysis - Food analysis - Body Fluid analysis – Chemical Sensors - Experiments - Process - Instruments – Application.

Reference Books:

1. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributers Pvt. Ltd, New Delhi, 7th edition, 1986.
2. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
3. Day R. A.& Underwood A. L., "Quantitative Analysis", 6th Edition, Printice Hall of India Pvt Ltd, New Delhi,2006.
4. G.D. Chritiain. Analytical Chemistry Wiley
5. Srivatsava A. K. & Jain P. C, "Chemical Analysis", S. Chand Publications, New Delhi, 3rd edition, 1997.
6. Chatwal G. R &Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
7. Valcarcel**,** Miguel, Principles of Analytical Chemistry, Springer, 2000.
8. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011
9. Zhou W, Wang Z. L, "Scanning Microscopy for Nanotechnology: Techniques and Applications", Springer, New York, USA, 2006.
10. R.P. Braun, Introduction to Instrumental Analysis, McGraw Hill
11. Caddy; Brian Strathclyde University, Glasgow, Scotland, "Forensic Examination of Glass and Paint: Analysis and Interpretation" Journal of Forensic Science, March 2003, Vol. 48, No. 2.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	1	1	2	1	3
CO2	3	2	2	2	3	2	1	2	1	2
CO3	2	2	2	3	2	2	2	1	2	-
CO4	1	2	1	2	2	1	-	1	2	1

CO5	1	1	2	1	2	1	2	2	1	3
CO6	1	2	1	3	3	2	3	1	1	2

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3018	Chemistry of non-transition Elements	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. summerize the chemistry of main group Compounds
2. utilize the inorganic polymers, cages and clusters for various applications
3. describe the importance of f-block elements and their applications

Course Outcomes:

Student will be able to

1. discuss the importance of alkali and alkaline earth metals
2. describe the importance of allotropy
3. summarize the importance of compounds of p-block elements
4. utilize the preparative methods of inorganic polymers
5. explain the structure and bonding in inorganic cages and clusters.
6. compare the chemistry of lanthanides and actinides and their applications

Unit 1: Chemistry of Alkali and Alkaline Earth Metals (10 Hours)

Periodic property, Synthesis of Crown ether and Cryptands, Application of Crown ethers in extraction of alkali and alkaline earth metals; Compounds of Beryllium-Aqua and hydroxo complexes, Beryllium chloride, Carbonates, Carboxylates, Dimethylberyllium, Beryllium azide, Grignard reagents and their application.

Unit 2: Polymorphism and Allotropy (8 Hours)

Allotropes of carbon-Fullerenes, Carbon nanotubes, Diamond, Graphite (synthesis, structure and applications); Allotropes of Phosphorus-Synthesis, Structureand Properties; Allotropes of Sulphur-Classification, Synthesis, Structureand Properties

Unit 3: Chemistry of Main group Elements (10 Hours)

Bonding, Preparation and Structure-Hydrides of boron, Boron oxides, Oxoacids, Borates, Aminoboranes; Chemistry of Silicates; Organometallic Compounds of B, Al, Si, Sn, Pb, and Bi-Synthesis, Structure and Reactions Oxides and oxyacids of S, Se, Te and N- Synthesis, Structures and Properties; Interhalogens,Polyhalides, Pseudohalides- Synthesis and Structure; Xenon compounds- Synthesis and Structure

Unit 4: Compounds of Cluster, Cages, Chains and Rings (10 Hours)

Hydroborane Clusters, Electron counting schemes: Effective Atomic Number (EAN) Rule – Wade–Mingos Rules, Styx numbers; P–S cages and P–O cages- Synthesis, Structure and Reactivity; Phosphazenes and Poly Phosphazenes; Borazines and Poly Borazines; S-N polymer, Boron nitrides, Polysilanes, Silicones - Carboranes, Metallacarboranes- Synthesis, Structures and bonding

Unit 5: Chemistry of f-Block Elements (7 Hours)

Abundance and Distribution - Separation of Lanthanides and Actinides – Lanthanide Contraction – Magnetic and Spectroscopic properties of Lanthanides - Transactinides - Applications

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Greenwood N. N. & Earnshaw A, "Chemistry of the Elements", Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
3. Purcell K. F & Kotz J. C., "Inorganic Chemistry" Cengage Learning, New Delhi, India, Reprint, 2010.
4. Shriver and Atkins, " Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
5. Cotton F. A & Wilkinson G, "Advanced Inorganic Chemistry", 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.

6. Driess M. & Nöth H, "Molecular Clusters of the Main Group Elements", Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2004.
7. Chandrasekhar V, "Inorganic and Organometallic Polymers" Springer-Verlag Berlin, Heidelberg Germany, 2005
8. Henderson W, "Main Group Chemistry", Royal Society of Chemistry, United Kingdom, 2000.
9. Chivers T & Manners I, "Inorganic Rings and Polymers of the p-Block Elements", Royal Society of Chemistry, United Kingdom, 2009.
10. Archer R. D, "Inorganic and Organometallic Polymers", John Wiley and Sons, New York, USA, 2001.

1 PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	1	1	2	1	3
CO2	3	2	2	2	3	2	1	2	1	2
CO3	2	2	2	3	2	2	2	1	2	-
CO4	1	2	1	2	2	1	-	1	2	1
CO5	1	1	2	1	2	1	2	2	1	3
CO6	1	2	1	3	3	2	3	1	1	2

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3019	Nuclear Chemistry and Solid State Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. summarize the applications of radioisotopes
2. outline the importance of solid state chemistry
3. utilize the nanomaterials for various applications

Course Outcomes:

Student will be able to

1. Describe the basic concepts of nuclear chemistry
2. Summarize the applications of radioisotopes
3. Outline the band theory of solids
4. Classify the various types of solid state reactions
5. Categorize the nanomaterials
6. Demonstrate the applications of coordination polymers

Unit 1- Nuclear Chemistry - I (9 Hours)

Nuclear Stability – Nuclear Fission – Nuclear Fusion – fission products and fission yields; Nuclear models – Shell model – Liquid drop model - Types of radioactive decay –Alpha decay – Theory of alpha decay - The tunnel effect - Beta decay – Types of beta decay - Electron capture - Dirac's theory - Nuclear deexcitation – Artificial radioactivity. Nuclear reactions: Bathe's notation – Types of nuclear reactions - Elastic and inelastic scattering –Cross section - Q value – Transuraniens - Photonuclear reaction - Radioactive capture - Evaporation and spallation – Buckshot hypothesis - Thermonuclear reactions

Unit 2 - Nuclear Chemistry -II (9 Hours)

Breeder reactor – Counting techniques: G.M., Ionization and Proportional counter - use of radio isotope in analytical chemistry, isotopic distribution analysis, neutron activation analysis, dating methods, applications of radio isotopes in agriculture industry and medicine. – Esterification – Friedal Craft's reaction - Solubility of sparingly soluble substance – Isotope dilution analysis – Carbon dating – Thyroiditis - Assessing the volume of blood in a patient - Brain tumor location - bone fracture healing- Optimum use of fertilizers - Control of predatory insects - Prospecting of water and petroleum.

Unit 3: Solid State Chemistry - I (9 Hours)

Conductivity in ionic solids - Band theory of solids -metals and their properties; semiconductors - extrinsic and intrinsic, - Hall effect; thermoelectric effects (Thomson, Peltier and Seebeck); insulators – dielectric, ferroelectric, pyroelectric and piezoelectric properties, multiferroics – Superconductivity - Magnetic properties: Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; select magnetic materials - spinels, garnets and perovskites, hexaferrites and lanthanide-transition metal compounds; magnetoresistance.

Unit 4: Solid State Chemistry - II (9 Hours)

Preparative methods: Solid state reactions, Chemical Precursor methods, co-precipitation, sol-gel metathesis, self-propagating high temperature synthesis, ion exchange reactions, intercalation/deintercalation reactions; hydrothermal and template synthesis, high pressure synthesis. Types of solid-state reactions - Powder x-ray diffraction, indexing the powder XRD patterns, Systematic absences, Structure factor.

Unit 5: Nanomaterials and Coordination Polymers (9 Hours)

Nanomaterials – Classification based on dimension - Types –methods of synthesis of inorganic nanomaterials -Top down – High energy Ball milling – microfabrication – Bottom up –CVD – Sol-Gel Method – Synthesis of Metal nanoparticles - Self assembled monolayers - Characterization of nanomaterials – Introduction to XRD, SEM and TEM – Applications – Coordination polymers – classification - examples-Applications.

Text Books:

1. Arnikar H. J, "Essentials of Nuclear Chemistry", New Age International Publishers Ltd., New Delhi, India, 4th edition, 2007.
2. G. Freindlander, J. W. Kennedy, E.S. Macias, and J. M.Miller, Nuclear and Radiochemistry, John Wiley and Sons, New York,1991.
3. West R, "Solid State Chemistry and its Applications", Wiley India Pvt. Ltd, New Delhi, India, 2007.
4. L. E. Smart and E. A. Moore, Solid State Chemistry - An Introduction, 4th Edition, CRC Press, 2012.
5. H. V. Keer, Principles of the Solid State, 2nd Edition, New Age International, 2017.
6. M. Weller, T. Overton, J. Rourke and F. Armstrong, Inorganic Chemistry, 6th Edition, Oxford University Press, 2014. (South Asia Edition 2015)
7. Shriver and Atkins, " Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
8. Cotton F. A & Wilkinson G, "Advanced Inorganic Chemistry", 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
9. C. P. Poole, F. J. Owens, "Introduction to Nanotechnology", Wiley-Interscience; 1st edition, 2008.
10. A.K. Das, D. Mahua, "An Introduction to Nanomaterials and Nanoscience", CBS Publishersand Distibutors Pvt. Ltd, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	3	2				1	3	1	
CO2		2	3				2	3	1	
CO3	3	1	2					3		
CO4		1	3					1		
CO5		2	3			1		3	1	
CO6		2	2					2	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3020	Organic Spectroscopy	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. outline the basic principles of organic spectroscopic techniques
2. illustrate the various spectroscopic analysis of organic compounds
3. discuss the structural elucidation of unknown organic compounds using various spectroscopic analysis

Course Outcomes:

Student will be able to

1. recognize the principles and applications of UV-Visible spectroscopy and ORD in elucidating the structure of organic compounds
2. illustrate the principle and applications of IR spectroscopy in elucidating the structure of organic compounds

3. describe the basic principle and applications of NMR spectroscopy in elucidating the structure of organic compounds
4. interpret proton decoupled NMR spectra, DEPT, 2D NMR and multi nuclear NMR spectroscopic analysis
5. analyze the basic principle and applications of mass spectroscopy in elucidating the structure of organic compounds.
6. apply the combined spectroscopic data in elucidating the structure of unknown organic compounds.

Unit 1: UV Visible spectroscopy and ORD (9 Hours)

The nature of electronic excitations, Origin of UV band structure, Principle of UV-Visible spectroscopy, Instrumentation- UV Visible spectrophotometer Solvents, Chromophore, Auxochrome, red shift and blue shift- hypo and hyper chromic shift- The Woodward–Fischer rules for dienes, trienes, α,β-unsaturated carbonyl compounds, aromatic compounds, Problems on calculating absorption maximum using Woodward-Fischer rules. Principles of ORD, Instrumentation – CD, Cotton effect, Octant rule, Axial halo ketone rule

Unit 2: FTIR spectroscopy (9 Hours)

Principle of IR spectroscopy, Infrared Absorption Process, Modes of Stretching and Bending, Bond Properties and Absorption Trends, Instrumentation- Fourier Transform IR Spectrophotometer, Preparation of Samples for Infrared Spectroscopy, Finger print region correlation chart and tables, concept of combination bands and overtones, Factors Influencing vibrational frequencies, IR spectrum of Alkanes, Alkenes, and Alkynes, Aromatic Rings, Alcohols, Phenols, Ethers, Carbonyl Compounds, Amines, Nitriles, Isocyanates, Isothiocyanates, Imines, Nitro Compounds, Carboxylate Salts, Sulfur Compounds, Phosphorous compounds-Problems in IR spectroscopy-Applications of IR

Unit 3: ^{1}H and ^{13}C NMR spectroscopy (9 Hours)

Absorption of energy, Mechanism of Absorption (Resonance), Chemical Shift and Shielding, The NMR Spectrophotometer-instrumentation, Chemical Environment and Chemical Shift, The Origin of Spin–Spin Splitting, Spin–Spin Splitting (n+1) Rule, Factors influencing chemical shift, Spin-spin relaxation, spin-lattice relaxation, NMR Solvents, The Coupling Constant, ^{1}H NMR absorptions by alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers,aromatic compounds, amines, nitriles, aldehydes, ketones, esters, carboxylic acids, amides, nitro alkanes and related problems. Carbon-13 NMR spectroscopy, Chemical Shifts, Proton-Coupled ^{13}C NMR Spectra, Proton-Decoupled ^{13}C NMR Spectra, Off-Resonance Decoupling, Nuclear Overhauser Enhancement (NOE), DEPT spectra, Carbon-13 NMR Solvents and related problems

Unit 4: Second order spectra and 2DNMR spectroscopy (9 Hours)

Second order spectra, The A2, AB, and AX Spin Systems, The AB_2 . . . AX_2 and A_2B_2 . . . A_2X_2 Spin Systems, Chiral Resolving Agents, Two-Dimensional Spectroscopic Methods- ^{1}H–^{1}H COSY spectroscopy, HETCOR spectroscopy, NOESY, ROSEY- definition—Hetero nuclear Coupling of Carbon to Deuterium, Hetero nuclear Coupling of Carbon-13 to Fluorine-19, Hetero nuclear Coupling of Carbon-13 to Phosphorus-31.

Unit 5: Mass spectroscopy (9 Hours)

Principle of mass spectroscopy, Instrumentation, Ionization Methods, Electron Ionization (EI), Chemical Ionization (CI), Desorption Ionization Techniques (SIMS, FAB, and MALDI), Electrospray Ionization (ESI), Molecular ion peak – Base peak, Metastable ions, Nitrogen rule, odd even rule, Isotopic effect, Structural Analysis and Fragmentation Patterns, - Mclafferty rearrangement, Other Cleavage Types, Alkanes, Cycloalkanes, Alkenes, Alkynes, Aromatic Hydrocarbons, Alcohols and Phenols, Ethers, Aldehydes, Ketones, Esters, Carboxylic Acids, Amines, Selected Nitrogen and Sulfur Compounds, Alkyl Chlorides and Alkyl Bromides -Problems, Structure elucidation of unknown compounds based on UV, IR, NMR and Mass spectroscopic data

Reference Books:

1. D. L. Pavia and G. M. Lampman Spectroscopy 4th Edition, Brooks Cole, 2012.
2. R. M. Silverstein, F. X. Webster, D. J. Kiemle, Spectrometric identification of organic compounds, 7th edition, John Wiley, 2005.
3. W. Kemp, Organic Spectroscopy, 3rd edition, Macmillan, 2011.

4. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, Mcgraw Hill, 6th edition 2007.
5. P. S. Kalsi, Spectroscopy of Organic Compounds, 6th edition, New age international, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1				3				2	2	1
CO2				3				2	2	1
CO3		2		3			1	2	3	2
CO4		2		3				2	3	2
CO5				3			1	2	3	3
CO6		2		3			1	2	3	3

"3"– High; "2"– Medium; "1"– Low; "-"– No correlation

20CH3021	Supramolecular Chemistry and Green Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the supromolecular constructs of current importance.
2. understand the principles of formation of various types of supramolecular architecture
3. describe the importance of solid state supramolecular chemistry and green chemistry

Course Outcomes :

Student will be able to

1. understand the various types of bonding in supramolecular chemistry
2. recognize the selectivity in formation of supramolecular chemistry and catalysis.
3. synthesize and assemble molecular structures of different shapes and dimensions.
4. construct supramolecular architecture based on of crystal engineering concepts
5. identify the application of supramolecular chemistry in appropriate fields
6. understand the importance of green chemical pathways in reactions and their applications.

Unit 1: Fundamentals of Supramolecular Chemistry (9 Hours)

Terminology and definitions – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Non-covalent interactions - Ion-Dipole Interactions - van der Waals Interactions - Hydrogen bonding - cation-pi, anion-pi, pi-pi interactions – hydrophobic effects – Kinetic and thermodynamic selectivity – Binding Constant - Guests in solution – Macrocyclic vs. acyclic hosts – High -dilution synthesis – Template synthesis.

Unit 2: Molecular Recogntion – Solution State (9 Hours)

Introduction -Cation binding – Podands - Crown ethers and cryptands – Spherands – Heterocrowns – Biological ligands: ion channels – Anion binding – Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins and dendrimers as catalysts.

Unit 3: SupramolecularMaterials (9 Hours)

Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Mechanically interlocked molecules- Molecular polygons – Rotaxanes, catenanes, and knots – Borromeates – Knotaxanes(structure and function of the above species). Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules. Application of Supramolecular Materials - molecular devices.

Unit 4: Crystal Engineering – Solid State (9 Hours)

Introduction – Zeolites: structure –composition –catalysis.Clathrates – Urea/thioureaclathrates – Trimesic acid clathrates –Hydroquinone and Dianin's compound – Clathrate hydrates (structure and function of the above species) – applications. Crystal engineering - Role of hydrogen bonds –Solid state reactivity – Metal organic frameworks – Guest properties of metal -organic frameworks.

Unit 5: Green Methodologies (9 Hours)

Basic principles of Green Chemistry - Atom Economy - Selection of starting materials - Designing biodegradableproducts - Green reaction conditions -Ionic liquids - Supercritical fluids - Fluorousphasereactions - Microwave and Ultrasound assisted reactions - Heterogeneous catalysis - applications of Green chemistry.

Reference Books :

1. Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Second Edition, CRC Press, 2012.
3. I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007
4. P.T. Anastas and J.C. Warner, Green Chemistry, Theory and Practice, Oxford University Press, 2000.
5. Crystal engineering using multiple hydrogen bonds, In Structure and Bonding, Ed:Andrew D. Burrows, Vol. 108, 55-96, 2004.
6. Supramolecular Chemistry: From Biological Inspiration to Biomedical Applications,Peter. J. Cragg, Springer Publishers, 2010.
7. Supramolecular Chemistry –Fundamentals and Applications. Advanced Textbook by T. KUnitake, K Ariga,Berlin: Springer-Verlag Heidelberg, 2006. 208p. ISBN 978-3-540-01298-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		1	2					1	
CO2		2						2	1	1
CO3	2		1	3	3			1	3	
CO4		1	2	2	3			2	2	
CO5						1	2			2
CO6	1	2	1	1	2	1	3	2	1	3

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3022	Applied Electrochemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basics of electrochemical techniques
2. get the knowledge about electrochemical synthesis and electroplating procedures
3. know about electrochemical cells and corrosion control techniques

Course Outcomes:

Student will be able to

1. understand the fundamentals of electroanalytical techniques
2. know about electrochemical synthetic routes
3. understand the concept of electrometallurgy and electroplating procedures
4. classify the batteries based on their application
5. know about different types of corrosion
6. choose the methods to resist corrosion

Unit 1: Electrochemical Techniques (9 Hours)

Current-voltage relationships - mass transfer - diffusion limited currents - kinetic currents - adsorption currents, voltametry, amperometry, coulometry, Polarography, impedance spectroscopy, cyclic voltametry, rotating disc electrodes, chronoamperometry, chronopotentiometry, chronocoulometry, conductometric and potentiometric titrations (basic principles and applications only in all the above methods).

Unit 2: Electrochemical Cells (9 Hours)

Electrochemical cells - components of electrochemical cells- Types of cells - divided and undivided cells - chlor-alkali cells mercury, diaphragm and membrane cells - electro-inorganic chemicals - chlorates, perchlorates - electrosynthesis of fluorine - electro-organic chemicals - electro-reduction of nitro and carbonyl groups - Kolbe synthesis - electrodimerisation - adiponitrile.

Unit 3: Electrometallurgy and Electroplating (9 Hours)

Electro winning and electro refining of Cu and Ni, production of aluminium - Hall-Heroult process - Electrolytic production of magnesium and sodium - Electroplating operations - preplating operations - electroplating of nickel and chromium - zinc electroplating - Gold plating - anodizing of Al - electroforming

Unit 4: Electrochemical Power Sources (9 Hours)

Thermodynamic reversibility - Classification of batteries – primary batteries: Dry Leclanche cells, alkaline primary batteries - Secondary batteries: Lead acid, Nickel cadmium, Lithium batteries – High temperature batteries - sodium-sulphur system - Fuel cells – Use of batteries in electric vehicles

Unit 5: Corrosion and Corrosion Control (9 Hours)

Pourbaix diagrams - kinetics of corrosion - Evans diagram - Corrosion current and corrosion potential - Theories of corrosion – Mechanism of corrosion – Dry corrosion – Electrochemical corrosion - atmospheric corrosion - crevice corrosion - bimetallic corrosion - stress corrosion - cracking - corrosion control and corrosion inhibitors - painting for corrosion control - cathodic protection - protection by sacrificial anodes.

Text Books:

1. Vijay G. Singh, "Applied Electrochemistry", Nova Science Publishers, 2010.
2. M. M. Baizer, "Organic electrochemistry", Dekker Inc. New York, 1983.
3. Schlesinger, "Modern Electroplating", John Wiley, 2002.
4. Raj Narayan, "An Introduction to metallic corrosion and its prevention", Oxford & IBH, 1983.
5. Thomas Reddy, "Linden's Handbook of Batteries", 4th Edition, McGraw-Hill, 2010.

Reference Books:

1. John O'M Bockris, Amulya K. N. Reddy, Maria E. Gamboa-Adeco, "Modern Electrochemistry", Vol.2 Part 1, Springer Science & Business Media, 2000
2. Allen J.Bard, Larry R.Faulkner, "Electrochemical Methods: Fundamentals and Applications", Second Edition, John Wiley & Sons, 2001.
3. Fritz Scholz, "Electroanalytical Methods - Guide to Experiments and Applications", 2nd Ed, Springer-Verlag Berlin Heidelberg, 2010.
4. Joseph Wang, "Analytical Electrochemistry", Third Edition, John Wiley & Sons, 2006.
5. Jocek Lipkowski and Phil N. Ross, "Electrocatalysis", John Wiley & Sons, 1998.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	1	2	3
CO2	-	-	-	1	-	-	1	1	1	1
CO3	1	-	1	1	-	1	1	1	2	2
CO4	1	1	1	1	1	1	1	1	2	3
CO5	-	-	1	1	1	1	1	1	1	1
CO6	-	-	1	-	-	-	-	1	1	2

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3023	Research Methodology and IPR	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. make the student conversant with Chemical Databases for their Literature collections
2. encourage students to develop curiosity towards commercial Chemistry softwares for their research
3. acquire knowledge about chemical reaction set-up and its scientific relevance.

Course Outcomes:

Student will be able to

1. describea research problem using the available chemistry literature.
2. analyze the components of rating like impact factor, citation index
3. realize the potential applications of chemical softwares
4. formulate the chemical reaction design and set-ups
5. create a research problem/proposal/manuscript with the awareness of plagiarism
6. learn the procedure for IPR

Unit 1: Chemical Literature Databases(9 Hours)

Chemical/Beilstein abstracts, CAS Number, DOI, Citation Index, Impact Factors, *h*-index, Scifinder/Reaxys design, Keyword Text Search, Identification of Research Problems, Scopus and Web of Sciences.

Unit 2: Chemistry Softwares(9 Hours)

Structure Tools, Chemical drawings and Chiral representations, Chemsketch, BioRad, Chemoffice, Chemdraw, 3D representation, Energy Minimization process, Substructure identifications, Chemical Structures for manuscript (ACS, RSC, Elsevier), Chemical compounds and Suppliers identification.

Unit 3: Chemical Reaction Design: **(9 Hours)**

Dean Stork Reaction set-up, Soxhlet extraction set-up, Barr hydrogenation Apparatus, Karl-Fisher Titrations for moisture content Concept of Rotary evaporator, Distillations, Auto Titrator, Reaction monitoring- dry/wet reaction set-up, Handling hygroscopic compounds. Low Temperature bath (freezing mixture), Anhydrous conditions.

Unit 4: Research Ethics and Technical writing (9 Hours)

Research ethics – Plagiarism, Effective literature studies approaches and analysis, Effective technical writing, how to write report, Paper - Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 5: Intellectual Property Rights (9 Hours)

Nature of Intellectual Property: Patents, Designs, Trade and Copyright - Process of Patenting and Development: technological research, innovation - patenting, development. International Scenario: International cooperationWIPO, onIntellectual Property. Procedure for grants of patents,Patenting under PCT- Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications.

Text Books:

1. R. Burns, "Introduction to Research Methods", Addison Wesley Longman, Third Edition, 1997
2. C. R. Kothari, "Research Methodology: Methods and Techniques", New- Age International, 2008
3. S.Usharani, "Analytical Chemistry", first edition, Mcmillan, India Ltd, 2000.
4. Vogel's Text Book of Practical Organic Chemistry by Furiniss, Harnaford, Smith, Talchall, VII Edition 2010

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1			3		1			3		2
CO2			2					1	3	
CO3	1			3				2	2	
CO4			2		3			2		3
CO5			2			3			1	3
CO6	1			2			2	1	3	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3024	Applied Polymer Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. know the classification and mechanism of polymer formation
2. understand the characterization techniques used in polymer chemistry
3. know concepts of polymer Nanocomposites.

Course Outcomes:

Student will be able to

1. acquire the basic knowledge about polymers.
2. know the Synthesis of various polymers, properties and choose the methods for characterizing the polymer.
3. understand the thermal and mechanical properties of various polymers.
4. develop various fabrication techniques.
5. understand the filler-matrix interaction .
6. recognize the importance and applications of nanofillers.

Unit 1: Fundamental Concepts of Polymers (9 Hours)

Polymers - Classification of polymers - functionality- polymers tacticity – interpenetrating network - structure property relationships – naturally occurring polymers – polysaccharides – cellulose and proteins

– polymerization reactions –- Bio polymers – introduction. Calculation based on functionality and Tacticity.

Unit 2: Principles and Mechanisms of Polymerization(9 Hours)

Principles and mechanisms of polymerization - Addition, step growth polymerization and coordination polymerization (Zeigler-Natta)- reactivity of functional groups – Carothers equation – Characteristics of step growth polymerization – examples – mechanisms – co-polymerization – monomer reactivity — composition - types.

Unit 3: Number Average and Molecular Weight Determination methods (9 Hours)

Polymer stereochemistry – amorphous, crystalline Glass transition temperature – viscosity – thermal behaviour of polymers – T_g , T_m and their relationship – elastic effect of polymers - Calculation of Molecular weight and number average in polymers.

Unit 4: Polymerization Process (9 Hours)

Bulk, solution, emulsion and suspension – industrially important polymers and their processes – polyethylene – polystyrene – Nylon 6,6 – PET – Inorganic polymers – polyphosphazines, sulphur based inorganic polymers – Elastomers – GRA, GRM, GRP, hypalon, Natural Rubber Vulcanization of rubber– Moulding processes – Injection, compression – Preparation of simple polymers in Lab scale.

Unit 5: Fabrication of Nanopolymers (9 Hours)

Introduction – Casting of films – Calendaring – hand lay-up and filament winding techniques - Polymer additives –Ablazing - Spinning – Melt, Dry, Wet and Cold Drawing - Introduction to polymer Nano composites – Clay, CNT Advantages and limitations of nanofillers– Applications of polymer Nanocomposites – packaging, automotive, mechanical components.

Reference Books:

1. V.R. Gowariker, N.V. Viswanathan, N.V.JayadevSreedhar, “Polymer Science”, I edition, New Age International Publishers Pvt. Ltd., New Delhi, 2008.
2. G.S. Misra, “Introductory Polymer chemistry”, New Age International Pvt. Ltd., 2008
3. Anil Kumar and Rakesh K. Gupta, “Fundamentals of polymer engineering” Tata McGraw Hill Publication Ltd., New Delhi, 2003 (revised and expanded edition)
4. R.J. Young, P.A. Lovell, “Introduction to polymers” Stanley Thomas Publishers, London, 2000
5. P. Bahadur, “Principles of polymer science”, Alpha Science International Ltd., 2nd Edition, 2005.
6. G. Odian, “Principles of Polymerisation”, IV Edition, Wiley Student Edition, New Delhi, 2007.
7. M.G. Arora, M. Singh and M.S. Yadav, “Polymer Chemistry” II revised Edition, Anmol Publications Pvt. Ltd., 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	2	2	1	-	-	2	2	1	2
CO2	3	3	2	2	1	1	1	3	2	1
CO3	-	1	1	1	1	2	3	1	2	3
CO4	1	2	2	3	3	3	2	2	2	1
CO5	1	1	1	2	2	1	1	2	1	2
CO6	1	1	2	2	1	3	3	1	3	3

“3”– High; “2”– – Medium ; “1”– - Low ; “-”– No correlation

20CH3025	Laboratory Chemistry for the daily life	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. make the student familiar with ayurvedic products in daily life
2. encourage students to develop curiosity towards the preparation of lab scale cosmetics, household chemicals etc.,
3. acquire knowledge about glass science like blowing, etching and engraving.

Course Outcomes:

Student will be able to

1. formulate ayurveda tooth paste/powder, mouth wash
2. prepare instant natural head ache relief bam and dish wash powders/bath bombs

3. lip balm from vegetable extracts and preparation of phenyl, hand sanitizer & disinfectants
4. glass blowing/fusion, engraving and itching techniques in day today chemistry labs.
5. learn the procedures for preparing natural insect repellant spray/ointment /oil
6. learn the techniques involved in preparation of homemade.

List of Experiments

1 Preparation of phenyl & washing powder.
2 Preparation of Natural Mosquito repellant oil
3 Preparation of Soap
4 Preparation of Head ache Bam
5 Preparation of Ayurvedic tooth powder
6 Preparation of natural lip Bam
7 Preparation of Alcohol based Hand sanitizer (Liquid/Gel)
8 Preparation of Bath bombs
9 Glass Welding technology (Glass fusion/Pending/Etching/Engraving)
10 Preparation of Ayurvedic Mouth Wash.
11 Preparation of Candle (Natural Essential Oil)
12 Identification of Adulterants in Food stuffs – simple experiments.

(Minimum 10 experiments to be completed)

References:

1. Surfactants, Disinfectants, Cleaners, Toiletries, Personal Care Products Manufacturing and Formulations by NPCS Board of Consultants & Engineers, NIIR Project Consultancy Services, 2016
2. Modern Technology of Soaps, Detergents & Toiletries (with Formulae & Project Profiles) 4th Revised Edition, P. K. Chattopadhyay, NIIR Project Consultancy Services, 2016

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	2	2	3
CO2	2	2	3	3	2	3	2	2	2	3
CO3	3	2	2	3	2	3	1	3	3	3
CO4	2	2	1	2	2	3	2	2	2	2
CO5	1	2	2	2	1	2	3	2	2	3
CO6	1	1	2	2	1	1	2	1	1	2

"3"– High; "2"– – Medium ; "1"– - Low; "-"– No correlation

20CH3026	Forensic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. know the methods of analyzing trace amounts of petroleum products in crime scene evidence.
2. get the knowledge about cases involving arson and chemistry of explosives
3. know about the classification and characteristics of the narcotics, drugs, psychotropic substances and alcoholic beverages

Course Outcomes:

Student will be able to

1. understand the types of petroleum products and their analysis
2. know about conditions for fire and scientific concept of evaluation of clue materials
3. understand the classification and composition of important explosive substances
4. learn the characteristics of narcotics, drugs, psychotropic substances and alcoholic beverages
5. know about testing of narcotics, drugs and psychotropic substances
6. learn the importance of analying narcotics, drugs and psychotropic substances.

Unit 1: Petroleum and Petroleum Products (9 Hours)

Petroleum products: types, by products, uses and importance - Examination of petroleum products: distillation and fractionation-Commercial uses of petroleum - Standard methods of analysis of petroleum

products for adulteration -Scope, importance and forensic importance of analysis for the adulterants in petroleum products.

Unit 2 : Cases Involving Arson (9 Hours)

Chemistry of fire - Conditions for fire - Fire scene patterns. Location of point of ignition - Recognition of type of fire - Searching the fire scene - Collection and preservation of arson evidence - Analysis of fire debris - Analysis of ignitable liquid residue - Post-flashover burning - Scientific investigation and evaluation of clue materials - Information from smoke staining

Unit 3: Explosives (9 Hours)

Introduction, classification, composition and characteristics - Synthesis and actions of explosives (TNT, PETN and RDX, IED) - Explosion process and affect types of explosions, post blast residue collection - Examination of explosion residues in laboratory (chemical and instrumental).

Unit 4: Narcotics, Drugs, Psychotropic Substances and Alcoholic Beverages – I (9 Hours)

Definition of narcotics, drugs and psychotropic substances - Broad classification – Narcotics, stimulants, depressants and hallucinogens - General characteristics and common example of each classification - Natural, synthetic and semi-synthetic narcotics, drugs and psychotropic substances - Designer drugs - Tolerance, addiction and withdrawal symptoms of narcotics, drugs and psychotropic substances - Crime scene search for narcotics, searching a vehicle.Clandestine drug laboratories - Collection and preservation of drug evidence.

Unit 5: Narcotics, Drugs, Psychotropic Substances and Alcoholic Beverages – II (9 Hours)

Testing of narcotics, drugs and psychotropic substances- thin layer chromatography, gas – liquid chromatography and high performance liquid chromatography - Presumptive and screening tests for narcotics, drugs and psychotropic substances in breast milk, salvia, urine, hair and antemortem blood - Drugs and driving - Dope tests - Analysis of narcotics, drugs and psychotropic substances in postmortem blood - Postmortem changes affecting the analysis of narcotics, drugs and psychotropic substances.

Text Books:

1. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition. The Foundation Press, Inc., New York, 1995.
2. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2007.
3. J R Almirall, K G Furton, Fire scene evidence, CRC Press, 2004.
4. Fred Smith, Jay A. Siegel, Handbook of Forensic Drug Analysis, Elsevier Academic Press, 2004.
5. F.G. Hofmann, A Handbook on Drug and Alcohol abuse, 2nd Edition, Oxford University Press, New York, 1983.

Reference Books:

1. W.J. Tilstone, M.L. Hastrup, C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton, 2013.
2. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey, 2004.
3. S. Ballou, M. Houck, J.A. Siegel, C.A. Crouse, J.J. Lentini, S. Palenik, Forensic Science, D.H. Ubelaker (Ed.), Wiley-Blackwell, Chichester, 2013.
4. J.D. DeHaan, Kirk's Fire Investigation, 3rd Edition, Prentice Hall, New Jersey, 1991.
5. S.B. Karch, The Pathology of Drug Abuse, CRC Press, Boca Raton, 1996.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	1	1	-	-	1	1	2	3
CO2	-	-	-	1	-	1	1	1	1	1
CO3	1	-	1	1	-	1	1	1	2	1
CO4	1	1	-	1	-	-	-	1	1	2
CO5	1	1	-	1	-	-	-	1	1	2
CO6	1	1	-	1	-	1	1	1	1	2

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3027	Advanced Photo and Electrocatalysis	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basics of photochemistry
2. get the knowledge about organocatalysis and organometallic-photocatalysis.
3. know about electrocatalysis and its application

Course Outcomes:

Student will be able to

1. understand the fundamentals of photochemistry and photocatalysis
2. describe organo-photocatalysis
3. illustrate organometallic photocatalysis
4. understand the fundamentals of electrocatalysis
5. apply electrocatalysis in various fields
6. illustrate the applications of photo-electrocatalysis

Unit 1: Photochemistry and Photocatalysis-Fundamentals (9 Hours)

Photochemical energy-Excited states, modesand dissipation of energy-Energy Transfer-Inter- and intramolecular energy transfer-Photo induced electron transfer-Quenching process-Oxidative and Reductive quenching-Quantum Efficiency and Excited State Lifetime.

Unit 2: Organo-Photocatalysis (8 Hours)

OrganicPhotosensitizer-Photo-redox catalysis-examples-Rose Bengal, Eosin Y, Mes-acridinium mediated photocatalytic organic transformations-Photocatalytic aerobic oxidation-
Photoinduced radical chain polymerizations.

Unit 3: Organometallic-Photocatalysis (10 Hours)

Various transition metal-based complexes as photosensitizers and photocatalysts-Photocatalytic CO_2 reduction and water splitting-Photocatalytic C-C, C-N and C-O bond formations.

Unit 4: Electrocatalysis-Fundamentals (9 Hours)

Electrode materials-Standard hydrogen electrode, glassy carbon electrode-Hg and Pt electrodes-Various factor influencing electrolysis-Solvent Effect-Catalyst Effect-Electrolytes-Calculation of Current efficiency and current density-Overpotentials.

Unit 5: Electrocatalysis-Advanced Applications (9 Hours)

Homogeneous electrocatalysis-Various transition metal-based complexes as homogeneous electrocatalysts-Heterogeneous electrocatalysis-Modified Electrodes-Electrocatalytic CO_2 reduction and water splitting-Electrocatalyticcarbonyl and imine reductions-Photo-electrocatalysis-Applications.

Text books:

1. B. König, Science of Synthesis: Photocatalysis in Organic Synthesis, Thieme, 2019, Verlagsgruppe, Stuttgart, New York, Delhi, Rio.
2. H. Ishida, "Electrochemical/Photochemical CO_2 Reduction Catalyzed by Transition Metal Complexes", Chapter 2, IntechOpen, 2018, DOI: 10.5772/intechopen.75199.
3. R. Ameta, S. C. Ameta, "Photocatalysis: Principles and Applications", CRC Press, Taylor & Francis Group, 2017.
4. N. Chouhan, R.-Shi Liu, J. Zhang, "Photochemical Water Splitting: Materials and Applications", CRC Press, Taylor & Francis Group, 2017.
5. M. M. Mukherji, S.P. Singh, "Reaction Mechanism in Organic Chemistry", MacmillanPublishers, 3rd Edition, Reprinted, 2010.
6. M. Aresta, "Carbon Dioxide as Chemical Feedstock", Wiley-VCH Verlag GmbH & Co. KGaA, 2010.
7. K. K. Rohatgi Mukherjee "Fundamentals of photochemistry", New Age International Pvt. Ltd., New Delhi, 2009.
8. S. Glasstone, "An introduction to Electrochemistry", East-West Press Private Limited, New Delhi, Reprint 2017.
9. M. M. Baizer, "Organic electrochemistry", Dekker Inc. New York, 2016.
10. John O'M. Bockris, Amulya K. N. Reddy, "Modern Electrochemistry Vol. I and II", Plenum Publishing, 2008.
11. B. Viswanathan, M. Aulice Scibioh, "Photoelectrochemistry: Principles and Practices", Alpha Science International Ltd, 2014.

20CH3028	Medicinal Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the principles of drug design and metabolism of current importance.
2. elucidate the enzyme structure and comprehend DNA-drug interactions
3. describe and apply the importance of antibiotics and cardiovascular diseases

Course Outcomes:

Student will be able to

1. comprehend the basic principles of drug metabolism and pharmacokinetics
2. understand the biochemical and physiological effects of drugs through pharmacodynamics.
3. build knowledge on the drug design with their classification and their recent developments
4. acquire the importance of various enzyme structure elucidation & dna-drug interactions
5. describe the classification of various antibiotics and their mode of action
6. discuss various cardiovascular diseases, mode of action of cardiovascular drugs and their side effects.

Unit 1: Introduction (9 Hours)

History of medicinal chemistry, general mechanism of drug action on lipids, carbohydrates, proteins and nuleic acids, drug metabolism and inactivation, receptor structure and sites, drug discovery development, design anddelivery systems, gene therapy and drug resistance.

Unit 2 - Drug Metabolism (9 Hours)

Introduction, oxidation, reduction, hydrolysis, conjugation, Pharmacokinetics: Drug Absorption, drug distribution, drug elimination, drug disposition, pharmacokinetic parameters, uses of pharmacokinetics in drug development process, Pharmacodynamics: Enzyme stimulation, inhibition, sulphonamides, membrane active drug, biotransformation, xenobiotics.

Unit 3 - Drug Design (9 Hours)

Development of new drugs, Procedures followed in drug design, Concepts of lead compound and lead modification, Concepts of pro-drugs and soft-drugs, Factors affecting bioactivity, Resonance, Inductive effect, Isosterism, Bio-isosterism, Spatial considerations. Clinical testing and synthesis of drugs - Various phases in preclinical testing and clinical trials –Theories of drug activity: Occupancy theory, Rate theory, Induced fit theory. Quantitative structure activity relationship (QSAR) - testing drugs in vivo – therapeutic index and therapeutic ratio

Unit 4-Elucidation of enzyme structure& Interactions (9 Hours)

Mechanism, kinetic, spectroscopic, isotopic and stereochemical studies. Chemical models and mimics for enzymes, design, synthesis and evaluation of enzyme inhibitors.DNA-protein interaction and DNA-drug interaction .Concepts of drug receptors.Elementary treatment of drug receptor interactions.Physico-chemical parameters: Lipophilicity, Partition coefficient, electronic ionization constants. LD-50, ED-50

Unit 5 - Antibiotics and Cardiovascular drugs(9 Hours)

Introduction and classification, synthesis uses and side effects of antibiotics (a) penicillin-V (b) penicilline–G (c) cephalosporin - mode of action of penicillin and cephalosporin. Cardiovascular diseases, arteriolar dilators, diuretics, adrenergic receptor blockers, synthesis mode of action, uses and side effects of cardiovascular drugs,

Reference Books

1. D.J.Abraham. Burgers medicinal chemistry and drug discovery, Wiley, 6th edition, 2003.
2. R. B. Silverman. The organic chemistry drug design and drug action, Academic Press, 3rd edition, 2014.
3. A.Gringuage. Introduction to medicinal chemistry-how drugs act and why, Wiley-VCH, 1934.
4. William O. Foye. Thomas L. Lemice and David A.Williams, Principles of Medicinal Chemistry, Wiley-VCH, 7th edition, 2002.
5. Graham L. Patrick.An Introduction to Medicinal Chemistry, Oxford, 6th edition, 2017.
6. AshutoshKar. Medicinal Chemistry, New Age International, 3rd edition, 2005.
7. Pandeya, S.N., and Dimmock, J.R., An Introduction to Drug Design, New Age International (2008).

8. Abraham, D.J., and Rotella, D.P., Burger's Medicinal Chemistry and Drug Discovery, Vol-1, Ed. John Wiley & Sons (2010) 7thed.
9. I. Wilson, Giswald and F. Doerge, Text Book of Organic Medicinal and PharmaceuticalChemistry, J.B. Lippincott Company, Philadelphia, 1971.

20CH3029	Photophysical Chemistry	L	T	P	C
		3	0	0	3

Course Objectives :

Enable the student to

1. acquire knowledge of photochemistry and photophysical principles
2. learn the importance of theory of photoreactions and kinetics of reactive intermediates
3. describe and apply the importance of photophysical principles on simple and macromolecules

Course Outcomes :

Student will be able to

1. comprehend thephotochemisty andphotophysical principles
2. explain the mechanisms of electronically excited states molecules through various concepts
3. build knowledge on the identification and characterization of transient intermediates by ultrafast modern techniques
4. acquire the importance of the theory of photoreactions
5. describe the kinetics of reactive intermediates
6. applythe photochemistry and photophysical principles on simple and macromolecules

Unit 1 - Principles and Concepts (9 Hours)

Laws of photochemistry, Atomic and molecular term symbols, Electronic transitions, Jablonski diagram and photophysical processes, Radiative transitions, Absorption and emission, Absorption coefficient, Phosphorescence, Intersystem crossing, Mechanisms of singlet-triplet conversion(spin-orbit coupling), Spin rephasing, Spin flip, Importance of electron jump between perpendicular orbital's, heavy atom effect, Examples of ISC between states of different configurations, Radiative rates, Radiationless transitions, Internal conversion, Energy gap law, Deuterium effect.

Unit 2 - Electronically Excited States (9 Hours)

Electronic, Vibrational and spin configurations, Excited state lifetime, Steady state and time resolved emission, Factors affecting excited state energy, Solvent effect, TICT, Origin of energy difference between singlet and triplet states, Excited state kinetics, Quantum yield expressions, Excimer and exciplex, Kinetics of luminescence quenching, Static and dynamic, Stern-Volmer analysis, Deviation from Stern-Volmer kinetics, Photoinduced electron transfer rates, Free energy dependence of electron transfer on rate, Photoinduced energy transfer, FRET, ESPIT, TBET, Rate and efficiency calculation of FRET. Fluorescence sensing of Analytes

Unit 3 - Theory of Photoreactions (9 Hours)

Visualization of reactions on excited state surfaces, Minima, Funnels and conical intersections.

Unit 4 - Identification of Minima on Excited State Surfaces (9 Hours)

Surface touching, Cleavage of s and p bonds, Diradicals, Salem diagrams, Photochemical generation and excited state reactions of reactive intermediates (carbenes, nitrenes, radicals, diradicals, and carbocations).

Unit 5 - Applications of Photochemistry and Photophyscial principles (9 Hours)

Measurement of fluorescence and phosphorescence and lifetimes, Introduction to time-resolved techniques for absorption and emission measurements, Detection and kinetics of reactive intermediates, Photochromic reactions and memory devices, Sensors, Switches and molecular machines, TiO2photocatalysis, Photosynthesis (plants), Intermediates in photoreactions, Identification and characterization through modern techniques, Flash photolysis, CIDNP, Photoacoustic, Stepscan IR.

References

1 1.Lakowicz, J. R., Principles of Fluorescence Spectroscopy, Springer, New York (2006), 3rded.
2 2.Kavarnos, G. J., Fundamentals of Photoinduced Electron Transfer, VCH publishers Inc., New York (1993).
3 3.Valeur, B., Molecular Fluorescence: Principles and Applications, Wiley-VCH Verlag GmbH, Weinheim (2002).

4 4.Turro, N. J., Ramamurthy, V., and Scaiano, J. C., Modern Molecular Photochemistry of Organic Molecules, University Science, Books, CA (2010).
5 5.Ninomiya, I., and Naito, T., Photochemical Synthesis, Academic Press, New York (1989)

20CH3030	Bioanalytical Chemistry and Biosensors	L	T	P	C
		3	0	0	3

Course Objectives :

Enable the student to

1. learn the structure and functions of biomolecules.
2. study the principle and application of electrophoresis and centrifugation
3. describe and apply immunological methods and biosensors for identification and determination

Course Outcomes :

Student will be able to

1. Comprehend the basic structure and functions of certain biomolecules
2. Understand the principle and application of electrophoresis
3. Build knowledge on the principles of centrifugation and types
4. Operate flow cytometry and apply for practical samples
5. Acquire the importance of various immunological methods and their applications
6. Able to construct biosensor for various biological molecules

Unit 1 - General principle (9 Hours)

Introduction - Sampling in biosystems, Biomolecules - lipids, proteins, amino acids, Nucleic acids, enzymes, carbohydrates – structure and functions with specific Examples

Unit 2 - Principle and application of electrophoresis (9 Hours)

principle of electro separation, types of electrophoreses, Instrumental electrophoresis applications of both charged and uncharged species. Protein purification and sequencing methods.Mass spectrometric methods for quantification of biomolecules of high molecular weights.

Unit 3 - Centrifugation and separation (9 Hours)

Isolation of biomolecules, basic principles of centrifugation, types of centrifugation methods for biomolecules,Microcentrifuges, High-speed centrifuges, Fractionation process, Ultracentrifugations, Density Gradient Centrifugation, Differential Centrifugation Flow cytometry, principles and applications.

Unit 4 - Immunological methods (9 Hours)

Immunoassays types, enzyme assay methods - fluorescence immune-labeling; enzyme-linked immunosorbent assays (ELISA); immunomagentic assays; Western immunoblotting assays; immunoaffinity chromatographic assays; immunocytological assays; immunoprecipitation assays; and lateral flow immunoassaysand Radioimmuno methods(RIA) - biological tracers and biomarkers - immunosensors. Current applications of immunological methods

Unit 5 - Sensors for identification and determinations (9 Hours)

Biosensors - enzyme, immunochemistry, nucleic acids, biomimetic receptors, construction of biosensors, nanotechnology, biosensor detection systems, characteristics and analytical applications of biosensors.

References

1 UnderastandingBioanalytical chemistry-principle and applications,Victor A Gault, Neville H McClenaghan,Wiley Blackwell, 2009.
2 BioanalyticalChemistry,David J Holme, Hazel Peck, Prentice hall, 3rd Edn., 2000
3 AnalyticalBiochemistry,AndreasManz, PetrasDittrich, NocolePamme, DimitrivIossifiedis, Imperial College Press, 2nd Edn., 2015.
4 Bioanalytical chemistry, Susan R Mikkelson and Eduard Corton, Wiley, 2004.

20CH3031	Nanomaterials Synthesis and Characterization	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the chemistry behind the nanomaterials synthesis
2. learn the characterization techniques for nanomaterials
3. get thorough knowledge about the application based nano-sized materials

Course Outcomes:

Student will be able to

1. recognize major classes of nanomaterials and chemistry behind.
2. describe relationships among structure & composition, physical & chemical properties.
3. analyze the sustainability of nanomaterials processing and applications.
4. apply appropriate laboratory techniques to process nanomaterials, determine their properties.
5. synthesis dimension-based nanomaterials and characterization
6. create the application based innovative nanomaterials

Unit 1: Introduction of Nanomaterials: (9 Hours)

Introduction: Nanoscale Science and Technology-Implications for Physics, Chemistry, Biology and Engineering; Classifications of Nanostructured materials, nano particles; Zero-dimensional, one-dimensional and two-dimensional nanostructures, size dependent properties – quantum confinement – optical properties - specific heat and melting point- mechanical properties – super plasticity - plastic deformation of ceramics - nanoceramics - catalytic properties.

Unit 2: Synthesis of Nanomaterials: (9 Hours)

Synthesis of nanomaterials - bottom-up and top-down approaches - nanoparticles - colloidal technique - homogeneous and heterogeneous nucleation - synthesis of metallic and semiconductor nanoparticles - stabilization of nanoparticles - sonochemical method-synthesis and properties of core-shell nanoparticles. Nanowires and nanorods - spontaneous growth - vapor-liquid-solid growth – template-based synthesis – nanostructured films - self-assembly - molecular self-assembly in solutions – self assembly of nanoparticles - Langmuir-Blodgett films - electrochemical deposition. Synthesis of bulk nano structured materials - Sol Gel processing- bulk and nano composite materials - Grinding - high energy ball milling – injection moulding - extrusion - melt quenching and annealing. Preparation methods: Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapor phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

Unit 3: One dimensional and Two dimensional nanostructures: (10 Hours)

Nanowires and Nanotubes: Evaporation-condensation - Vapor- liquid - solid (VLS) - surface and bulk diffusion – kinetics – growth of various nanowires –control of size –precursors and catalysts - single- and multi- wall CNT - Si nanowires – density and diameter – doping in nanowires - Carbon nanotube (CNT) and its Applications: Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, electronic, vibrational, mechanical and optical properties of CNT; applications of CNT and Fullerenes. - Graphene and its Functionalization: Graphene, structure of Graphene, synthesis and functionalization of Graphene, electronic application of Graphene, Electrochemical deposition, Graphene Oxide. Fullerenes - graphene - carbon nanotubes (CNTs) - SWCNT- MWCNT – synthesis - methods of opening, filling and purifying carbon nanotubes – geometrical structure of CNTs – electronic structure of CNTs – metallic and semiconducting CNTs – CNTFETs – CNT circuits - prospects of all-CNT nanoelectronics.

Unit 4: Advanced Characterization of Nanomaterials: (9 Hours)

Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, Thermogravimetric Analysis, Differential Scanning Calorimetry, Thermo mechanical Analysis, X-Ray, neutron diffraction. interpretation of results of – XRD – XPS - AES – EDS - SEM - STM – AFM – TEM - HRTEM - BET surface area and porosimetry - UV-Vis - FTIR and Raman spectroscopy - Thermal analysis – TGA, DTA and DSC. Self assembly-Self Assembled Monolayers (SAM) - Vapour Liquid Solid (VLS) approach - Chemical Vapour Deposition (CVD) - Langmuir-Blodgett (LB) films - Spin coating - Templated self assembly Electrochemical approaches: Thin films -Epitaxy –Lithography - Working Principles.

Unit 5: Applications of Nanomaterials: (8 Hours)

Dimension, Size and Shape based Applications –Energy materials – Biological and Environmental Applications – Nanomaterials in Healthcare - Nanomaterials for Day-to-day applications.

References:

1. W. Gaddand, D. Brenner, S. Lysherski and G. J. Infrate (Eds), Handbook of nanoscience, Engg. and Technology, CRC Press, 2002.

2. G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.
3. J. George, Preparation of thin films, Marcel Dekker, InC., New York, 2005.
4. C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.
5. Physical properties of Carbon Nanotube-R Satio
6. Applied Physics of Carbon Nanotubes : Fundamentals of Theory, Optics And Transport Devices - S. Subramony & S.V. Rotkins
7. Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing 10. Nanoscale materials -Liz Marzan and Kamat
8. Carbon Nanomaterials for Environmental and Biological Applications, Bergmann and Machado., Springer.
9. Introduction to Nanotechnology- Charles P Poole & Frank J. Ownes.

20CH3032	Stereoselective Synthesis	L	T	P	C
		3	0	0	3

Course objectives:

Enable the student to

1. classify the types of asymmetric synthesis
2. emphasize the substrate and reagent control of stereoselectivity in an asymmetric reaction
3. design asymmetric reactions of synthesizing new chiral compounds

Course outcomes:

The students will be able to

1. compare the types of asymmetric synthesis
2. predict the substrate and reagent control of stereo selectivity in an asymmetric reaction
3. summarize the types of chiral reagents
4. acquire knowledge on asymmetric synthesis using chiral pool methodology
5. apply the methodology of utilizing chiral auxiliaries in asymmetric synthesis
6. analyze the methods and merits of various types of chiral catalysis

Unit 1: Introduction to asymmetric synthesis (9 Hours)

Enantioselectivity and diasteroselectivity, importance of asymmetric synthesis, conditions for an efficient asymmetric synthesis, Types and strategies in asymmetric synthesis- advantages and limitations of each strategy, enantioconvergent Synthesis, resolving agents and resolution of common functional groups, analytical methods for determining enantiomeric excess.

Unit 2: Substrate and reagent control of stereoselectivity (9 Hours)

Asymmetric synthesis with chiral substrates: Nucleophilic addition to α –chiral carbonyl compounds, Electrophilic addition to α – chiral olefins - epoxidation, cyclopropanation, hydroboration – oxidation, alkylation of enolates of β-chiral carbonyl compounds. Asymmetric synthesis using chiral reagents: Chiral organo boranes ,- application in hydroboration, reduction and allylation reactions, Chiral lithium aluminium hydride application in reduction of prochiral ketones, Michael addition to α ,β – unsaturated carbonyl compounds, chiral lithium amides.

Unit 3: Asymmetric synthesis using chiral pool methodology (9 Hours)

Types of chiral pools, Amino acid and sugar derived asymmetric syntheses, enantiomeric scaffolding, Double stereo differentiation Matched pair and mismatched pair example from aldol reaction and hydroboration reactions, enantioselective and diasteroselective additions.

Unit 4: Asymmetric synthesis using chiral auxiliary (9 Hours)

Champhor derived auxiliaries, menthol derived auxiliaries chiral pyrrolidines, oxithiane, oxazolidine-2-one, oxazoline, 2-phenylcyclohexanols, 8-phenylmenthol, *chiral* (S)-1-amino-2-methoxymethylpyrrolidine (SAMP), chiral (*R*)-1-amino-2-methoxymethylpyrrolidine (RAMP), hydrazones- selected examples.

Unit 5: Asymmetric synthesis using chiral catalyst (9 Hours)

Organometallic catalysts, Hydrogenation catalyst, Sharpless epoxidation catalyst, semicorin catalyst, Jacobson catalyst, selected reactions. Organo catalysts: Chiral amino acid derived compounds, tertiary amines, phosphanes, phosphoramides, ureas amidines, imines, diols, sulphides in asymmetric reactions – selected examples.

Text books:

1. Stereochemistry of Organic Compounds by Ernest L. Eliel, Samuel H. Wilen, Lewis N Mander, Wiley student edition 2010, New Delhi: Wiley India
2. Catalytic Asymmetric Synthesis: Iwao Ojima, 3rd edition 2010, Wiley.

Reference books:

1. Robert Gawley and Jeffry Aube, Principles of Asymmetric Synthesis, 2nd edition, Elsevier 2012.
2. B. List, Benjamin (Ed.) Asymmetric Organocatalysis, Topics in Current Chemistry book series Springer 2009
3. E. N, Jacobsen, A. Pfaltz, H. Yamamoto, Comprehensive Asymmetric Catalysis Eds. Springer 2004.
4. H. B. Kagan, Aymmetric Synthesis, Thieme Medical Publishers, Ist Edition., 2003.
5. G. Q. Lin, Y. Li and A. S. Cchan Principles and applications of asymmetric synthesis, Wiley-Interscience 2001.
6. Daniel J. O'Leary, Methods for the Asymmetric Synthesis of Complex Organic Molecules, Lecture Notes 2001.

20CH3033	Chemistry of Biofuels	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the students to

1. learn the types of biodiesel sources
2. understand the processes to convert biodiesel from various sources.
3. describe about the physical and chemical properties of biodiesel and engine performance.

Course Outcomes:

The student will beable to

1. understand the various alternative fuels available.
2. prepare biodiesel and analyze its performance.
3. analyze the biodiesel based on physical and chemical parameter.
4. develop new catalyst and method for biodiesel preparation
5. understand the current research scenario in biodiesel.
6. design a biodiesel plant.

Unit 1: Energy Demand: (9 Hours)

Energy crisis – conventional – non conventional energy - crude oil production – importance of Biodiesel – chemical structure - Biomass feedstock - Bio-ethanol – Biodiesel - Classification of waste as fuel – Conversion devices – pyrolysis, gasifiers, digestors.

Unit 2: Biodiesel and its production (9 Hours)

Various vegetable oils and their important properties - waste vegetable oil and animal fat characteristics – fatty acid composition – oil extraction – oil refining process – types of Transesterification – Acid - Base catalysis mechanism – Application.

Unit 3: Biodiesel Characterization (9 Hours)

Free fatty acid – Kinematic Viscosity – Acid Value – Cloud and Pour Point – moisture content – peroxide value – carbon residue – saponification value – Gas chromatography –Fatty acid methyl ester value – Rancidity.

Unit 4: Green Methodologies for Biodiesel Production (9 Hours)

Catalysts - Preparation of heterogeneous nano based catalyst – Layered Double Hydroxide (LDH) – Metal oxides – Nano composites - waste materials as catalyst – Enzyme catalyst - characterization – XRD – SEM - Properties – Microwave assisted synthesis of biodiesel – different parameter - Frequency – Time – concentration – catalyst ratio - Ultrasound assisted synthesis of biodiesel – Pulse mode – Continuous mode – different parameter.

Unit 5: Biodiesel storage and stability (9 Hours)

Advantages – disadvantages – oxidation of biodiesel – Antioxidants – Natural antioxidants – Storage stability – ASTM methods – oxidation stability – induction time - Performance in engines – Emission characteristics in diesel engines.

References:

1. 1. R. Navanetha krishnaraj, Jong- sung Yu, Bio Energy – OppotUnities and Challenges, pp. 241-276, CRC Press, Taylor & Francis Group. ISBN – 13: 978-1-4987-2205-6. 2014
2. Ayhan Demirbas, Biodiesel A Realistic Fuel Alternative for Diesel Engines, Springer-Verlag London Limited 2008, ISBN-13: 9781846289941
3. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
4. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997. ISBN 0-76-80-0052-1.
5. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
6. Introduction to Biomass Energy Conversions, Sergio C. Capareda, CRC press, Taylor & Francis, 2014.
7. Non Conventional Energy Resources, G.D. Rai, 8th reprint, Khanna Publisher, 2013.

20CH3034	Glass Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the composition of glass and techniques to determine the glass fractures
2. learn the techniques to match glass fragments and various techniques in determining the composition of Glass
3. examine the quality of the glass in practical studies and future glasses.

Course outcomes:

Student will be able to

1. understand the history of glasses in forensic field.
2. know the glass fracture examination.
3. investigate glass densities and recovery of glass pieces.
4. select appropriate instruments for analyzing the glass and complex mixture
5. analyze varies studies of glass by using spectroscopic techniques.
6. choose special type of glasses for different applications.

Unit 1: Fundamental of Glass and its history(9 Hours)

Glass – introduction – composition – types – history of glass – Properties of glass (optical and Non Optical) – Physical, Chemical, Optical properties - Glass and it heat response – Laboratory glass – Distillation (Ancient (Greek & Arabic) – present – Future) – Forensic Glass and its various tests.

Unit 2: Glass Fractures and its Analysis (9 Hours)

Glass Fractures – Types (Compressive, Tensile, Shear) – Characteristic of Glass Fractures - Industrial (Tempered – Windshield Glass- Laminated) – Laboratory (Borosilicate – Soda- Lead) – Analysis of various Hardness of Glass – Forensic Examination of Glass fractures with simple case studies.

Unit 3: Glass Evidence and investigation (9 Hours)

Glass density tests (Window, Pyrex, Leaded) – Gun Shot – Windshield Glass fragments – Glass (Evidence) collection of glass evidence (Recovery from Dry and Wet cloths) - Analysis of fragments – Direction of Force - 3R Rules (Radial Fracture, Right Angle, Reverse side of force) – Case studies.

Unit 4: Spectroscopic Studies on Glass (9 Hours)

Refractive index – Becke Line – Color – Elemental Analysis (Semi Quantitative Techniques – Xray Fluorescence, Scanning Electron Microscopy – Quantitative Techniques – Flameless atomic Absorption spectroscopy) – Oil Immersion Method – Emmons.

Unit 5: Special types of Glass in Forensic Medical Field (9 Hours)

Application and properties of Bullet Proof glasses – Swap Test Glasses (Polymeric) – Glass ceramic – Glass fibre – Chromatic Glasses – Optical glass – Float glass (Gorilla Glass) – Case studies based on bullet proof glasses and Swap test glasses.

Reference Books

1 The Forensic Analysis of Glass Evidence: Past, Present, and Future, Brooke Weinger Kammrath , Andrew C. Koutrakos , Meghan E. McMahon, John A. Reffner, Wiley - VCH Verlag GmbH & Co. KGaA , 2016.

2 Forensic science – Fundamentals and applications -Jay. A. Seigel, Wiley Blackwell, Academic press., edition 2012
3 Basic Principles of Forensic Chemistry - Khan, JaVed, Kennedy Thomas, Springer 2012.,
4 Forensic Examination of Glass and Paint: Analysis and Interpretation (Taylor & Francis Forensic Science Series) Edited by Brian caddy 2012
5 The third edition of Forensic science – basics -Jay. A. Seigel, KarthyMirokovits – Wiley Blackwell, third edition 2016, CRC press.
6 Forensic Interpretation of Glass Evidence- James michale Curran – Tacha Natalie – John S. Buckleton, Taylor and Francis, 2014
7 Materials Analysis in Forensic Science, Ist Edition, Max M. Hock, 2016, Academic Press.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	1	2	2	2
CO2	2	1	2	2	1	2	1	2	1	1
CO3	1	2	2	3	1	2	1	3	2	2
CO4	2	2	2	1	2	1	2	2	1	1
CO5	1	2	1	2	2	2	-	2	2	1
CO6	2	1	2	1	2	2	1	3	2	1

"3"– High; "2"– – Medium ; "1"– - Low; "-"– No correlation

20CH3035	Applied Chemical Crystallography	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. discuss the bravais lattices and crystal systems
2. explain the principle and application x-ray diffraction
3. relate the principle and application of database and chemical crystallography

Course Outcomes:

Student will be able to

1. discussthe bravais lattices
2. relate the principle and application of x-ray diffraction
3. understand the different crystal growth methods
4. examine the principle and application of crystal systems
5. examine the principle and application of crystal symmetry
6. discuss the application and database of chemical crystallography

Unit 1: Bravais Lattices and Crystal Systems (9 Hours)

Introduction, fourteen space lattices, symmetry of the fourteen Bravais lattices, coordination or environments of Bravais lattice, Unit cell, Seven crystal systems,points, Lattice and Unit Cell Parameters

Unit 2: Crystal Symmetry (9 Hours)

Introduction, 1D symmetry, Concept of 2D symmetry and lattices, notations of symmetry elements, space groups in 2D, 3D lattices, 32 point groups and their notations.Diffraction and symmetry, symmetry operations, symmetry elements, proper rotations and improper rotations.Crystal symmetry and properties

Unit 3: X-ray Diffraction (9 Hours)

What are X-rays, generation and classification of X-ray, X-ray sources, diffraction of X-rays, Bragg's law.X-ray scattering from electrons, X-ray scattering from atoms, X-ray scattering from a unit cell, Laue's analysis of X-ray diffraction, Ewald's synthesis.

Unit 4: Crystal Growth and Evaluation (9 Hours)

Methods of crystal growth, identification of phases and morphologies, in-situ cryo crystallization, crystal growth under external stimuli, Protect your crystals, Solution methods, Sublimation,Fluid-phase growth, Solid-state synthesis. Evaluation- Microscopy, X-ray photography, Diffractometry. Crystal mounting-Standard procedures, Air-sensitive crystals, Crystal alignment.

Unit 5: Application and Database (9 Hours)

Intermolecular interactions, Molecular recognition, Self-assembly, Crystal engineering, Supramolecular synthon, Hydrogen-bond directed assembly, polymorphs, applications in pharmaceutical industry, Crystallographicdatabases.

Reference books:

1. Clegg, W.; Blake, A.J.; Gould, R.O.; Main, P.Crystal structure analysis: principles and practice, 2nd edition, Edited by William Clegg, Oxford University Press/International Union of Crystallography, 2002.
2. Wai-Kee Li, Gong-Du Zhou and Thomas C. W. Mak.Advanced Structural Inorganic Chemistry, Oxford University Press/International Union of Crystallography, 2008.
3. The Basics of Crystallography and Diffraction. Fourth Edition. By Christopher Hammond. IUCr Texts on Crystallography, IUCr/Oxford Science Publications, 2015.
4. Fundamentals of Crystallography (2nd Ed.) by C. Giacovazzo, Oxford University Press, USA, 2002

20CH3036	Chemistry of Carbenes	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. learn the various methods to generate carbene intermediates
2. understand the reactions of metal carbenoids
3. realize the applications of inorganic carbenes in organic transformations

Course outcomes

The students will be able to

1. outline the preparation of carbene intermediate
2. explain the use of diazo compounds as precursor for metal carbenoids
3. demonstrate the reactions of metal carbenoids in insertion reactions
4. understand the cycloaddition and sigmatropic reactions of metal carbenes
5. explain the synthesis of nhc and its application in organic transformations
6. realize the application of organometallic carbene in organic transformations

Unit 1: Introduction to carbenes and carbenoids(9 Hours)

History, structure of carbene, 1,2-elimination, singlet and triplet, Reimer-Tiemann reaction, diazomethane preparation, from diazald, Esterification and methylation with CH_2N_2, Reaction of carbene with pyrrole, Ethyl diazoacetate from glycine ester, Regitz synthesis of diazo compound, Bamford Steven reaction. Wolf rearrangement and Ardnt-Eistert reaction.

Unit-2:Reactions of metal carbenoids -I**(9 Hours)**

Insertion reactions of metal carbenoids, C-H insertion, intramolecular C-H insertion, mechanism, O-H insertion, N-H insertion, S-H insertion, Si-H insertion, cyclopropanation, cyclopropenation, reaction with aromatic ring

Unit 3:Reaction of metal carbenoids-II (9 Hours)

1,2 sigmatropic rearrangement and 2,3 sigmatropic rearrangement, intramolecular sigmatropic rearrangement, reaction of metal carbenoids with ketone, carbonyl ylide, 1,3-dipolar cycloaddition, intramolecular 1,3-dipolar cycloaddition, applications in synthesis of complex molecules

Unit 4:N-Heterocyclic carbenes(9 Hours)

Preparation and reactions – Imidazole based NHC, Thiazole based NHC preparation, Benzoin reaction, Stetter reaction applications and advantages over KCN, Intramolecular Stetter reaction. NHC based metal catalyst and their applications in organic transformations

Unit-5:Metal carbenes(9 Hours)

Grubb's catalyst-first and second generation catalyst, structure, ene metathesis, enyne metathesis and applications in macrolide synthesis- Tebbe reagent- Reaction with ester and amide, enol ether and enamine synthesis, Fischer carbene and Schrock carbenes, synthesis and reactions, metal carbynes from Fischer carbene

Reference Books

1. J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005
2. Carey, F.A, and Sundberg. R. J, "Advanced Organic Chemistry Part – B: Reactions and Synthesis", Plenum Press, 2008
3. Clayden, J; Greeves, N; Warren, S. Organic Chemistry, 2nd edition, Oxford University press, 2012

4. Huheey J. E, Keiter E. A &Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.

20CH3037	Metal-Organic Framework Materials	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the students to

1. learn the theoretical and practical knowledge in the field of metal-organic framework materials.
2. Synthesize and characterize the metal-organic framework materials
3. Understand thepotential use for environmental and energy applications.

Course Outcomes:

The students will be able to

1. understand the necessary competences for the preparation and implementation of MOF
2. predict the correct choice of characterization methods of the prepared materials,
3. determine the quantitative analysis of the measurements and interpretation of the results.
4. identify the correct MOF characterization and its functional groups
5. Apply knowledgeto actual MOF applications in normal life
6. To Demonstrate anunderstanding of the MOFs with other porous and non-porous materials

Unit-1: Classification of Metal Organic Frameworks (9 Hours)

Introduction, Background and Ongoing Chemistry of Porous, Coordination Polymers, Frameworks with High Surface Area,Secondary Building Units (SBUs):The Design Principles of MOFs, Lewis Acidic Frameworks, Soft Porous Crystals, Multifunctional Frameworks, Porosity and Magnetism, Classification of metal-organic framework materials (MOFs) and large scaleMOF Suppliers.

Unit-2: Synthesis of Metal Organic Frameworks (9 Hours)

Synthesis methods of MOFs-Preparation of Multifunctional Frameworks, Mixed Ligands and Mixed Metals, Types of Synthesis: Hydrothermal, Solvothermal, and IonothermalRoutes, Types of Linkers: Carboxylate, Phosphonate, and N-basedLigands, General Synthetic Strategy for Extended Organic linkers, Designing Linker Synthesis.

Unit-3: Properties of Metal Organic Frameworks (9 Hours)

The properties of MOFs (crystallinity, porosity, chemical and thermal stability)Mechanical Properties, Analysis ofTheir Acidic Behavior, Stability Issues,Redox Properties, Catalytic Properties, Inclusion, Adsorption/Separation, Gas Storage, Fluid Separation.

Unit-4: Characterization of Metal Organic Frameworks (9 Hours)

Methods for structure characterization of MOFs (XRD, SEM/EDX, porosity (DFT), surface area (BET), thermal analysis, Particle analysis, Solid State NMR, crystallography, Electron Paramagnetic Resonance, IR and Raman Spectroscopies ProbingMOFs Structureetc.)

Unit-5: Applications of Metal Organic Frameworks (9 Hours)

Design and use of MOFs for capture, separation and storage of gases. Design and use of MOFs for heat storage. Design and use of MOFs for use in catalysis. Other uses of MOFs (sensors, (semi)conductors, drug-delivery systems, etc.)

Reference Books:

1. MacGillivray, L.R., Metal-organic frameworks: design and application, Hoboken : John Wiley & Sons, cop. 2010, ISBN 978-0-470-19556-7.
2. Furukawa, H., Cordova, K. E., O'Keeffe, M. &Yaghi, O. M. The chemistry and applications of metal-organic frameworks. Science 341, 1230444 (2013).
3. Helal, A., Al-Maythalony, B.A., Yamani, Z.H., Cordova, K.E., Yaghi, O.M., The chemistry of metal-organic frameworks for CO2 capture, regeneration and conversion. Nature Reviews Materials 2, 17045 (2017).
4. Mazaj, M., Kaučič, V., ZabukovecLogar, N., Chemistry of metal-organic frameworks monitored by advanced X-ray diffraction and scattering techniques. Actachimicaslovenica, 63, 440-458 (2016).
5. Stefan Kaskel, The Chemistry of Metal–OrganicFrameworks, 2016,Wiley-VCH Verlag GmbH & Co.KGaA, Boschstr. 12, 69469 Weinheim,GermanyISBN: 978-3-527-33874-0.

20CH3038	Advanced Main Group Chemistry	L	T	P	C

		3	**0**	**0**	**3**

Course Objectives:

Enable the students to

1. conversant with the applied main group chemistry
2. understand the importance of main group chemistry in catalysis.
3. impart knowledge about biological applications of main group chemistry.

Course outcomes:

The Student will be able to

1. learn synthetic methodologies involved in main group chemistry
2. describe the mechanism of ring opening polymerization
3. understand the effect of main group element on polymeric materials
4. realize catalytic applications and cost reduction
5. understand the importance of main group molecules in developing modern technologies
6. analyse applications in toxicology and biology

Unit 1: Synthesis and classification of main group compounds (12 Hours)

Classifications, synthesis, characterisations andproperties of Organoboranes, Organosilicons, Organophosphorous, Organoantimony, Organobismuth, Organogermanium, Organoarcenic, Organostannane, Organoselenium, Organotellurium compounds.

Unit 2: Main group polymers (10 Hours)

Synthesis, characterisation and properties of polysilanes-polygermanes-polystannenes-polyphosphazenes-polyphospholes-B, S, As (Arsole), Se and Te containing conjugated polymers.

Unit 3: Catalytic applications (8 Hours)

Frustrated Lewis Acid Pairs (FLP)-Low valancemain group compounds-classifications-applications in small molecules activation-catalysis- Advantages.

Unit 4: Optoelectronic Applications (7 Hours)

Solid state luminescence-theory-π conjugated molecules containing main group elements-applications in OLED, solar cell andforensic science.

Unit 5: Medicinal chemistry applications (8Hours)

Chemical sensing-fluoride and cyanide-bio imaging (cancer cells and mitochondria)-photodynamic therapicapplications-boron and antimony based anion transporters.

References:

1. Thomas Baumgartner andFriederJackle, Main Group Strategies towards Functional Hybrid Materials, First edition, John Wiley & Sons, 2018.
2. Ali Morsali, LidaHashemi, Main Group MetalCoordination Polymers,John Wiley & Sons, 2017
3. Kin-YaAkiba, Organo Main Group Chemistry, John Wiley & Sons, 2011
4. James E. Mark, Harry R. Allcock, Robert West, Inorganic Polymers,Oxford University Press, 2005
5. Ronald D. Archer, Inorganic and Organometallic polymers, John Wiley & Sons, 2001
6. A. G. Massey, Main Group Chemistry, 2nd Edition, John Wiley & Sons, 2000
7. Das, Kumar V.G, Main Group Elements and their Compounds, Springer-Verlag Berlin Heidelberg, 1999.

20CH3039	**Chromatography**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

Enable the student to

1. recognize the importance of various chromatographic techniques in chemistry
2. understand the principles of different separation techniques for various molecules
3. acquire the knowledge on principles and instrumentation of sophisticated chromatographic equipments for compound purification

Course Outcomes:

Student will be able to

1. understand the principles of chromatographic techniques
2. distinguish between different chromatographic techniques

3. apply the appropriate technique for separation in gc
4. attain the knowledge on purification of any prepared compound
5. utilize the proper separation technique for the purity check
6. interpret the chromatogram obtained from various techniques

Unit 1: Column Chromatography (9 Hours)

Polarity, Functional groups related polarity- Thin Layer Chromatography – Column chromatography – Silica gel Mesh- TLC applicator - Column Volume - repopole applications in chemical analysis- Applications of Column Chromatography.

Unit 2: Gas Chromatography (9 Hours)

Introduction to gas Chromatography- Theory –Working Principles — Instrumentations- Detectors- Columns- Components of GC- GC for volatile substances – Applications of GC.

Unit 3: Liquid Cromatograpy (9 Hours)

Introduction to HPLC Chromatography- Theory –Working Principles Pumps, Injection portal, Column chemistry- Method developments–Detectors– Instrumentations- – Applications of HPLC. UHPLC and UPLC

Unit 4: Super Critical Fluid Chromatography (9 Hours)

Introduction of SFC- Theory- Principles of SFC, Instrumentations- CO2 as carrier Phase- Preparative approach- Method development and cost estimation-Components of SFC-Application of SFC.

Unit 5: Flash Chromatography (9 Hours)

Introduction of Flash Chromatography- Semi-Preparative Approach- Theory- Principles of FC, Instrumentations- Four Solvent Systems- Detector-ELSD- Method development and translations – Fractional Collector- Flash Cartridges – Solvent and Time benefits -Components of FC-Application of FC.

Reference Books:

1. Chatwal G. R &Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
2. G. Sharma, B K Chaturvedi,Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011
3. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
4. Srivatsava A. K. & Jain P. C, "Chemical Analysis", S. Chand Publications, New Delhi, 3rd edition, 1997.
5. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributers Pvt. Ltd, New Delhi, 7th edition, 1986.
6. Valcarcel, Miguel , Principles of Analytical Chemistry, Springer, 2000.

20CH3040	Water Treatment Technologies	L	T	P	C
		3	0	0	3

Course objectives:

Enable the students to

1. gain the knowledge on sources of water, importance of water quality and its standards for usage.
2. understand about objectives of water treatment.
3. understand about the purification process like, sedimentation, coagulation, filtration and softening methodologies involved before supplying to public.

Course outcomes:

Student will be able to

1. understand the roll and importance of drinking water quality and control of water borne diseases.
2. understand the need of purity of water to reduce the transmission of various diseases in urban and rural community.
3. judge the standards of water before supplying to a community.
4. Apply the type of treatment required with respect to water quality.
5. gain the knowledge on water softening methods and utilization of water
6. explore the need of new technology in water purification

Unit 1: Water Quality Standard and Industrial waste water (9 Hours)

Introduction – Sources of water, Importance of water quality and standards. Objectives of Water treatment– Uses of Water by industry – Sources and types of industrial wastewater – Water Pollution: Sources of water and their contamination, Types of pollutants, Industrial effluents- pulp and paper mills, Sugar, Distillery, Domestic wastes, Effluents from water treatment plants. Eutrophication – causes, effects and control measures. Industrial wastewater disposal and environmental impacts – Reasons for treatment of industrial wastewater – Regulatory requirements – Industrial waste survey – Industrial wastewater generation rates, characterization and variables

Unit 2: Industrial Water Pollution Control and Treatment (9 Hours)

Sources and characteristics of industrial wastewater, effects on environment. Standards related to industrial wastewater. Waste volume reduction, waste strength reduction, neutralization, equalization and proportioning. Advanced wastewater treatment. Industry specific wastewater treatment for chloro- alkali, electroplating, distillery, tannery, pulp and paper, fertilizer, etc. Treatment technology of coal washery and coke oven effluents. Equalization – Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal – Refractory organics separation by adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors. Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation

Unit 3: Determination of water quality parameters (8 Hours)

Chemistry of water and waste water – water pollution, pollutants in water, water quality requirement , potable water standards, wastewater effluent standards principles of determination of water quality parameters like pH, alkalinity, BOD, COD, hardness, lethal doses of pollutants – sulphides, chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water.

Unit 4: Methods of treating waste water (9 Hours)

Primary, secondary and tertiary methods of treating- Chemical- Coagulation and Flocculation- Theory of Coagulation. Types of Coagulants, reactions, Coagulant Aids, Determination of Optimum dose of Coagulants. Design Criteria and numerical problems on estimation of coagulants- Water Softening - Ions causing Hardness, Degree of Hardness, and Removal techniques, Problems associated with hardness. Fluoridation and De-fluoridation techniques. Special requirements of Industrial water supply.-Physical - adsorption-

Unit 5: Advanced Treatment Technologies (10 Hours)

Electrochemical – electrocoagulation, electro dialysis- - reverse osmosis-Biological methods- Microbial Treatment - Degradation of high concentrated toxic pollutants, non-halogenated, halogenated petroleum hydrocarbons metals. Rural wastewater systems – Septic tanks, two-pit latrines, Ecotoilet, soak pits. advantages and limitations-Need for the advanced technologies in waste water treatments- nanomaterials in wastewater treatments -TiO_2, ZnO- composite materials TiO_2/CNT, TiO_2/GO- composite immobilized on polymers-challenges in these technologies.

Text Books:

1. Waste Treatment and Disposal 2nd edition Paul T Williams, Wiley, 2005
2. "Wastewater Treatment", Rao M.N., Datta A.K., (2008), 3rd edition, Oxford & IBH Publishing Co. New Delhi.
3. CPHEEO Manual, (1991), "Water Supply and Treatment", GO Publications.
4. Water Treatment Grade 1 WSO: AWWA Water System Operations WSO (2016), American Water Works Association

Reference Books:

1. Peavy, H.S., Rowe and Tchobonoglous,G., (1985), "Environmental Engineering", McGraw Hill
2. Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning, New Delhi, 2009
3. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, (1984), Environmental Engineering, McGraw Hill., 1984
4. Joshua Armstrong, Introduction To Water Treatment: Handbook Edition, (2019), Independently published

20CH3041	Bioorganometallic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. summarize the importamce of bioorganometallic chemistry
2. describe the structure and function of bioorganometallic systems
3. discuss the importance of bioorganometallics in medicinal chemistry

Course Outcomes:

Student will be able to

1. define the bioorganometallic complexes
2. discuss the role of organometallic compounds in cataysis
3. analyse the factors affecting the catalysis
4. recognize the importance of hydrogen energy
5. synthesize the compounds for specific application
6. summarize the role of bioorganometallic complexes in medicinal chemistry

Unit 1: Introduction (9 Hours)

Bioorganometallic chemistry – Definition – Examples - Proteins – Aminoacids – Vitamin B12 and its coenzymes –Structure - Coenzyme B12 dependent enzymes – Methyl cobalamin – catalysis – Mechanism – Homolysis – Heterolysis - Electrochmistry

Unit 2: Model complexes of vitamin B12 based enzymes (10 Hours)

Model complexes – Vitamin B12 model complexes – Cobaloximes and other model complexes – Preparation – Characterization - Cis influence – trans influence – Catalysis - Applications – Tuning the catalyst – Organic transformation - Hydrogen production – Chain transfer catalyst

Unit 3: The Bioorganometallic Chemistry of Hydrogenase (9 Hours)

Hydrogenase – Significnce Types – [FeFe] Hydrogenase – [FeNi] Hydrogenase – [Fe] Hydrogenase – Active sites - Mechanism – Model complexes - Dihydrogen metal complexes

Unit 4: Bio-Organometallic Systems for the Hydrogen Economy (9 Hours)

Introduction –Electrocatalysis - Electrode Materials for Hydrogen Evolution and Uptake – covalent attachment of catalyst to the electrode surface – Non-covalent attachment of a catalyst – Photocatalysis – Photocatalysts - Light driven system for hydrogen economy – Photoelectrodes - Examples – Iron based catalysts – Nickel based catalysts – Molecular based photocatalysts

Unit 5: Medicinal properties of organometallic compounds (8 Hours)

Organometallic pharmaceuticals - Anticancer and antimalarial drugs - Ruthenium complexes – Metallocene complexes – Half sandwich complexes - Tuning the activity of the catlayst

Reference Books:

1. Advances in Bioorganometallic chemistry – Edited by Toshikazu Hirao and Toshiyuki Moriuchi, Elsevier 2019
2. Topics in Organometallic Chemistry, Vol-17- Bioorganometallic chemistry, Edited by G, Simonneaux, Springer-Verlag Berlin Heidelberg 2006
3. Bioorganometallic Chemistry- Applications in Drug Discovery,Biocatalysis, and Imaging, Edited by G. Jaouen and M.Salmain, Wiley-VcH-2015
4. Bioorganometallics: Biomolecules, Labeling, Medicine, Edited by G. Jaouen, Wiley-VCH Verlag GmbH & Co, 2005
5. Designing organometallic compounds for catalysis and therapy, A. L. Noffke, A. Habtemariam, A. M. Pizarro and P. J. Sadler, Chem. Commun., 2012,48, 5219-5246, Royal Society of Chemistry, 2012

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1						3	1	-
CO2	2	2	2					2	2	-
CO3	3	1		3				2	3	1
CO4	3	1						3	-	2
CO5	2				2			1	2	-
CO6	1			1				1	-	-

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3042	Supramolecular Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the supromolecular constructs of current importance.
2. understand the principles of formation of various types of supramolecular architecture
3. describe the importance of solid state supramolecular chemistry and crystal engineering

Course Outcomes :

Student will be able to

1. understand the various types of bonding in supramolecular chemistry
2. recognize the selectivity in formation of supramolecular chemistry and catalysis.
3. Identify and design receptors for cations, anions and neutral molecules.
4. synthesize and assemble molecular structures of different shapes and dimensions.
5. construct supramolecular architecture based on of crystal engineering concepts
6. identify the application of supramolecular chemistry in appropriate fields

Unit 1: Fundamentals of Supramolecular Chemistry (9 Hours)

Terminology and definitions – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Non-covalent interactions - Ion-Dipole Interactions - van der Waals Interactions - Hydrogen bonding - cation-pi, anion-pi, pi-pi interactions – hydrophobic effects – Kinetic and thermodynamic selectivity – Binding Constant - Guests in solution – Macrocyclic vs. acyclic hosts – High -dilution synthesis – Template synthesis.

Unit 2 : Molecular Recogntion – Solution State (9 Hours)

Introduction -Cation binding – Podands - Crown ethers and cryptands – Spherands – Heterocrowns – Biological ligands: ion channels – Anion binding – Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins and dendrimers as catalysts.

Unit 3: Supramolecular Materials (9 Hours)

Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Mechanically interlocked molecules- Molecular polygons – Rotaxanes, catenanes, and knots – Borromeates – Knotaxanes(structure and function of the above species). Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules.

Unit 4: Crystal Engineering – Solid State (9 Hours)

Introduction – Zeolites: structure –composition –catalysis.Clathrates – Urea/thioureaclathrates – Trimesic acid clathrates –Hydroquinone and Dianin's compound – Clathrate hydrates - Crystal engineering - Role of hydrogen bonds –Solid state reactivity – Metal organic frameworks – Guest properties of metal - organic frameworks.

Unit 5: Applications of Supramolecular Chemistry (9 Hours)

Application of Supramolecular Materials - molecular devices - molecular wires, molecular rectifiers, molecular switches, molecular logic gates - Supramolecular catalysis – Supramolecular Chemistry in Nanotechnology - examples of recent developments in supramolecular chemistry – Applications of Supramolecular chemistry in medicine.

Reference Books:

1. Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.
2. I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007
3. Crystal engineering using multiple hydrogen bonds, In Structure and Bonding, Ed:Andrew D. Burrows, Vol. 108, 55-96, 2004.
4. Supramolecular Chemistry: From Biological Inspiration to Biomedical Applications, Peter. J. Cragg, Springer Publishers, 2010.
5. Supramolecular Chemistry –Fundamentals and Applications. Advanced Textbook by T. KUnitake, K Ariga,Berlin: Springer-Verlag Heidelberg, 2006. 208p. ISBN 978-3-540-01298-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2		2	1				1	1
CO2				2	3			2	2	
CO3		2		3		1		1		
CO4				1	2	2			3	
CO5										1

CO6	1	2		2	2	2	2	1		2

"3"– High; "2"– – Medium ; "1"– - Low ; "-"– No correlation

20CH3043	Analytical Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. recognize the importance of various analytical techniques used in chemistry
2. understand the principles of different chromatographic separation techniques
3. acquire the knowledge on principles and applications of spectroscopic techniques and thermal methods

Course Outcomes:

Student will be able to

1. distinguish between different chromatographic techniques
2. apply the appropriate technique for analysis
3. attain the knowledge on analysis of any prepared compound
4. utilize the proper spectroscopic technique for the characterization
5. interpret the spectra obtained from various techniques
6. demonstrate the thermal methods and x-ray diffraction methods of analysis.

Unit 1: Chromatography (9 Hours)

Theory - Principle, instrumentation and applications of the following – Column, thin layer, and ion-exchange chromatography – Gas chromatography - High performance liquid chromatography - applications in chemical analysis.

Unit 2: Infrared Spectroscopy (9 Hours)

Introduction to electromagnetic radiation wave length – Wave ratio - Regions of the spectrum, characterization of electromagnetic radiation - The vibrating diatomic molecule – Selection rule - - harmonic oscillator - Vibrations of polyatomic molecules – Fundamental vibrations and overtones – Basic Principle - Instrumentation –Sampling techniques - Factors affecting vibrational frequencies - Application to chemical compounds (organic and inorganic compounds) - Finger print region - Identification of functional groups - Simple problems in functional group identification using IR spectrum.

Unit 3: Electronic Spectra (9 Hours)

Electronic spectra of diatomic molecules – physical properties – laws of absorption – absorption transitions – Jablonski diagram – auxochromes - chromophores – effects of conjugation – Woodward-Fieser rules for α,β-unsaturated carbonyl compounds and dienes – aromatic systems with extended conjugation – application to organic and inorganic compounds – instrumentation of absorption spectroscopy.

Unit 4: Nuclear Magnetic Resonance Spectroscopy (9 Hours)

Nuclear spin theory - Interaction between spin and magnetic field - Population of energy levels - Larmor precession frequency - Relaxation processes – Instrumentation – Continuous wave and FT NMR - Proton NMR - Chemical shifts and its measurement – TMS - Reference compound – Factors affecting Chemical Shifts – Solvents in NMR -Spin-spin coupling – spin spin splitting - Theory - Magnitude and factors affecting coupling constant - Long Range coupling – Second order spectra – AX, AMX, and ABX systems- Simplification of complex spectra - Applications of 1H NMR to determine the structure of simple organic compounds - Introduction to Two Dimensional NMR (1H-1H COSY) spectroscopy.

Unit 5: Thermal Methods of Analysis and X-ray Diffraction method (9 Hours)

Thermal Analysis techniques Principle and applications of Differential Thermal Analysis (DTA) - Differentials Scanning Calorimetry (DSC) - Thermogravimetric Analysis (TGA) Thermometric titration - Theory – Instrumentation of DTA, DSC and TGA – Factors affecting TG, DTA and DSC Curves – Principles of X-ray diffraction Methods – Instrumentation — Diffraction pattern – Bragg's Law – Structure factor – Reliability factor - Applications

Reference Books:

1. Chatwal G. R &Anand S. K, “Instrumental Methods of Chemical Analysis”, Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
2. Kalsi P. S, “Spectroscopy of Organic Compounds”, New Age International Publishers, New Delhi, 6th Edition, 2004.
3. Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
4. Srivatsava A. K. & Jain P. C, “Chemical Analysis”, S. Chand Publications, New Delhi, 3rd edition, 1997.
5. Willard H, Merrit L, Dean J. A. & Settle F.A., “Instrumental methods of chemical analysis”, CBS Publishers and Distributers Pvt. Ltd, New Delhi, 7th edition, 1986.
6. Valcarcel, Miguel , Principles of Analytical Chemistry, Springer, 2000.
7. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2	1	-	2	-	2	3	1
CO2	3	2	3	2	1	2	-	1	2	1
CO3	1	1	2	2	-	1	-	-	2	-
CO4	2	3	2	1	1	2	-	1	2	1
CO5	3	2	3	2	1	2	-	2	3	-
CO6	2	2	1	2	-	2	-	1	2	1

“3”– High; “2”– – Medium ; “1”– - Low ; “-”– No correlation

20CH3044	Essentials of Forensic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the various fields of forensic chemistry
2. learn the methods of searching and analyzing arson and post-fire evidence
3. understand the classification of explosives and bomb scene management

Course Outcomes:

The student will be able to

1. understand the methods involved in forensic chemistry
2. realize their significance of forensic chemistry in various fields
3. analyze the various types of petroleum products.
4. realize the classification of beverages
5. apply the techniques of locating hidden explosives
6. characterize and analyze arson evidence and post-fire analysis.

Unit 1: Significance of Forensic Chemistry (9 Hours)

Forensic Chemistry - Introduction - branches - Preliminary screening - presumptive tests (colour and spot tests) - Examinations procedures involving standard methods and instrumental Techniques - Qualitative and quantitative forensic analysis of inorganic and organic material - Chemical fertilizers - (N,P,K) - Insecticides (Endosulfan, Malathion, Carbaryl) - Metallurgical analysis (Fe, Cu, Zn, Au, Ag) - Natural products (tobacco, tea, sugars, rubber) – Industrial chemicals - Cosmetics of forensic interest and their role in crime investigation, General Chemistry of Colorants, Dyes, Pigments & Polymers - Physical and chemical examination of adulterated and non-adulterated oils and fats, Analysis of chemical fertilizers

Unit 2: Petroluem Products (9 Hours)

Petroleum Products, Properties and Testing -adulteration of petroleum products -Analysis of common petroleum products including, Petrol, Kerosene, Diesel, Lubricating Oil, Furnace Oil and Grease as per BIS specifications. Analysis of Dyes used in petroleum products, Chemical fingerprinting of petroleum products - Standard method of analysis of petroleum products

Unit 3: Alcoholic Beverages (9 Hours)

Composition and analysis of alcoholic and non-alcoholic beverages, country made liquor, illicit liquor and medicinal preparations containing alcohol –Characteristics of Beer, wines and Whisky, Congeners in alcoholic beverages, Laws and penalties as per Excise/ Act -Forensic analysis of distilled and fermented liquors including illicit liquors - Common adulterants and toxic substances in alcoholic beverages –

Analysis of Narcotic Drugs and Psychotropic Substances - classification of NDPS -Forensic examination of NDPS –Clandestine laboratories

Unit 4: Explosives (9 Hours)

Definition - Chemistry of explosives - Deflagration and Detonation phenomenon - Characteristics of high and low explosives - Dust explosion, Gas/vapour explosion, BLEVE, Effect of blast wave on structures & human and Pyrotechnics - Improvised Explosive Device: Definition and Components- Explosives Initiation -Detection of Hidden Explosives -Approach to scene of explosion - post-blast -explosion residue collection - Systematic analysis of explosives and explosion residues in the laboratory using chemical and instrumental techniques- Examples- Profiling and tagging of explosives- Interpretation of results, Explosives Act andExplosive Substances Act.

Unit-V: Fire & Arson (9 Hours)

Light and Flame, Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron; Backdraft, Thermo-chemistry of Fire, Heat Capacity and Phase changes, Accelerants & types of accelerants, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapour density, vapour pressure, Fire extinguisher. Analysis of arson residues by conventional and instrumental methods- Documenting the fire or crime scene - Scheme of analysis - Extraction of samples from debris -Clean-up -, Analysis - Interpretation of GC-MS spectra -Report Writing & Court Room Testimony - Components of Forensic Reports

Text Books:

1. James, S. H., Nordby, J. J. and Bell, S "Forensic Science: An Introduction to Scientific and Investigative Techniques", 4th Edition, CRC Press, USA, 2015 ISBN-10: 9781439853832, ISBN-13: 978-1439853832,
2. Paul Worsfold, Alan Townshend and C. F. Poole, "Encyclopedia of Analytical Science", 2nd Edition, Elsevier Academic Press, 2005, ISBN:0127641009, 9780127641003
3. Beveridge, A, "Forensic Investigation of Explosions 2nd Edition, CRC Press, 2011, ISBN: 1420087258, 9781420087253
4. Yallop, H. J, 'Explosion Investigation", Forensic Science Society &, S. S. Kind, 1980, 0950242551, 9780950242552
5. Narayanan, T. V: Modern Techniques of Bomb Detection and Disposal, R. A. Security System, 1995.
6. Yinon, J. and Zitrin, S, "Modern Methods and Applications in Analysis of Explosives", John Wiley & Sons, 1996, ISBN: 04719656nm26, 9780471965626
7. Clarke, "Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids and Postmortem Material" Edited by Moffat, A. C., Osselton, M. D., Widdop, B. and Clarke, E.G.C: 3rd edition, Pharmaceutical Press, 2004, ISBN: 0853694737, 9780853694731
8. Almirall, J. R. and Furton, K. G, "Analysis and Interpretation of Fire Scene Evidence", CRC Press, 2004, ISBN: 0203492722, 9780203492727
9. Bogusz, M. J, "Forensic Science Volume 2 of Handbook of Analytical Separation", Elsevier Science, 2000, ISBN: 0444829989, 9780444829986
10. Dettean, J. D and Icove, J. D, " Kirk's Fire Investigation", 7th Edition, Pearson, 2011, ISBN-10: 0135082633, ISBN-13: 978-0135082638
11. Gough, T. A, "The Analysis of Drugs of Abuse" John Wiley, 1991. ISBN: 0471922676, 9780471922674
12. Saferstein, R and Hall, A. B, "Forensic Science Hand Book, Vol. I, II and III," 3rd Edition, Taylor & Francis Group, 2020, ISBN: 1498720196, 9781498720199
13. N. D. P. S. Act, 1985 with amendments
14. Explosive Act with amendments
15. Explosive Substances Act with amendments
16. Bureau of Indian Standards: Specifications and Methods of Analysis for Alcoholic Beverages.
17. Bureau of Indian Standards: Specifications and Methods of Analysis for Petroleum Products.
18. Working Procedure Manual: Chemistry, Explosives & Narcotics, B.P. R & D, 2000
19. DEA Manual: Analysis of Controlled Substances
20. Saferstein, R., "Criminalistics: An Introduction to Forensic Science", 11th Edition, Pearson, 2015, ISBN-139780133458824

21. Sarkar, S: Fuels and Combustion, Orient Blackswan, 1989, ISBN: 8125003967, 9788125003960
22. Standard Methods of Chemical Analysis
23. AOAC: Official Methods of Analysis
24. Indian, British & U. S. Pharmacopeias

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1						1	2	1
CO2	1	2		1	2		1	2	1	
CO3	2	1	2		2		1	2	1	1
CO4	3		2	2		2	1	2	2	2
CO5	2	3		1			2	2		
CO6	2	2	1	2			1			

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3045	Forensic Tools and Techniques	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the various fields of analytical chemistry
2. learn the methods of qualitative methods of analysis
3. understand the principles of quantitative methods of analysis

Course Outcomes:

The student will be able to

1. understand the methods involved in analytical chemistry
2. understand the terms used in analytical chemistry
3. realize the significance qualitative analysis
4. realize the importance of volumetric analysis
5. understand the importance of gravimetric analysis
6. apply the various types of separation methods

Unit 1: Significance of Analytical Chemistry (12 Hours)

Nature and scope of analytical chemistry in Forensic chemical analysis -Concept of Mole, Molecular Mass and Molecular Weight,- Classification of analytical methods - Conventional and instrumental methods of analysis - Theoretical principles of analytical chemistry – Law of mass action and its application – Le Chatelier and Braun principle –Dissociation theory – Electrolytes and non-electrolytes – Classification of acids, bases and salts according to their degree of dissociation – Dissociation of acids, bases and salts – Dissociation constants – Common ion effect – Solubility product – Ionization of water – pH value – pOH value – Relation between pOH & pH scale – pH scale - Buffer solutions - Buffer action – Preparation of buffer solutions –Methods of sample preparation in organic and inorganic analytical chemistry- Scientific Calculations: Scientific volume and weight measurements, Density, Specific Gravity, Specific Volume, Percentage, Ratio Strength, and other Expressions of Concentration

Unit 2: Qualitative analysis (9 Hours)

Organic reagents in detection of inorganic ions – Oxidizing and reducing agents in organic chemistry – Inorganic and organic spot tests – Micro chemical tests – Physical tests – Qualitative inorganic analysis –Colour spot tests in Forensic Biological, Chemical and Physical analysis, Microcrystalline test - Centrifugation Techniques, Basic principles of sedimentation, types of centrifuges - Group separations for cations and anions – Interfering radicals - Elemental analysis of organic compounds– Functional group analysis – Schemes of identification of unknown solids, liquids and gases (inorganic and organic) – Confirmation tests and their importance – Sensitivity and limit of detection

Unit 3: Volumetric Method of Analysis (9 Hours)

Titrimetric methods of analysis – General principle – Equivalence point and end point –Fundamental requirement of a titrimetric method – Standard solution – Detection of end point – Indirect titrations– Calculations in titrimetry – Aqueous acid-base titrimetry –Preparation of standard solutions – Primary standards – Indicators – Theory of indicators –Acid-base titrimetry in nonaqueous solvents – Redox titrimetry – Oxidation and reduction – Oxidant and reductant – Iodimetry and iodometry –

Permanganometry – Dichromatometry – Precipitation methods –Argentometry – Complexometry – EDTA methods

Unit 4: Gravimetric Method of Analysis (9 Hours)

Gravimetric methods of analysis – Basic Digestion of precipitates – Washing of precipitates – Drying and ignition of precipitates – Thermal decomposition of precipitates – Organic precipitants – examples - Factors affecting gravimetric analysis – Requirements of quantitative separation – The process of precipitation – Saturated and supersaturated solution – Nucleation – Crystal growth – Conditions of precipitation – Completeness of precipitation – Factors influencing solubility – Purity of a precipitate – Adsorption of ions on precipitates - Coprecipitation – Occlusion and post-precipitation

Unit 5: Chemical Separation Techniques (6 Hours)

Physical separation methods – Distillation – Extraction – Precipitation –Crystallization - Solvent extraction (Liquid-liquid extraction), Solid phase extraction, Solid phase microextraction (SPME). Phenolphthalein in trap case: Chemistry and Forensic examination of Phenolphthalein used in Bribe trap cases, and related legal issues.

Textbooks:

1. Christian G.D, "Analytical Chemistry" John Wiley & Sons, 6th Edition, 2004 ISBN-10: 0471214728, ISBN-13: 978-0471214724
2. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008 ISBN-10: 0582226287, ISBN-13: 978-0582226289
3. Svehla, G: Vogel's Qualitative Inorganic Analysis, 7th Edn., Longman, 1996, ISBN-10: 0582218667, ISBN-13: 978-0582218666
4. Verma, R. M: Analytical Chemistry, 3rd Edn, CBS Pub, New Delhi, 2019, ISBN-10: 9788123902661ISBN-13: 978-8123902661
5. Ghoshal, A., Mahapatra, B and Nad, A. K, New Central Book Agency, Kolkata, 2000 ISBN: 9788173813023, 9788173813023
6. Kasture, A. V., Mahadik, K. R., Wadodkar, S. G and More, H. N: PharmaceuticalAnalysis 13th edition, NiraliPrakshan, Pune ISBN: 978-81-85790-07-7
7. Alexeyev, V. N: Qualitative Chemical Semi micro Analysis, CBS Pub., New Delhi, 2004, ISBN-10: 9788123902791, ISBN-13: 978-8123902791
8. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
9. Feigl, F and Anger, V, "Spot Tests in Inorganic Analysis", Elsevier, 1982, ISBN-10: 0444409297; ISBN-13: 978-0444409294
10. F. Feigl and Anger, V, "Spot Tests in Organic Analysis", 7th Edition, Elsevier, 1983
11. Harris, D. C "Quantitative Chemical Analysis", 9th Edition., W. H. Freeman Publishers; 2015, ISBN-13: 978-1464135385, ISBN-10: 146413538X
12. Vogel, A: Qualitative Organic Analysis, 2nd Edition., reprinted 2002, CBS Pub, New Delhi,
13. Connors, K. A: A Text Book of Pharmaceutical Analysis, 3rd Edn., John Wiley, 1999, Publisher: Wiley-Blackwell; 3rd Revised edition edition (27 October 1982), ISBN-10: 0471090344 ISBN-13: 978-0471090342
14. Furniss, B. S., "Vogel, A. I: Text Book of Practical Organic Chemistry" Pearson Education India, 1989, ISBN: 8177589571, 9788177589573
15. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2		1	1		1	2	2	
CO2	2	1		2		2	1	1	
CO3	3	1		1			2		2
CO4	3	1	1	2		2	2	2	1
CO5	2	1			2		1	1	
CO6	2			1			2	1	

"3"– High; "2"– – Medium; "1"– - Low; "-"– No correlation

20CH3046	Instrumental Methods of Analysis - I	L 3	T 0	P 0	C 3

Course Objectives:

Enable the student to

1. Understand the basic concepts of spectroscopy
2. learn the principles of vibration and electronic spectroscopy
3. understand the principles of radiochemical methods and electrochemical methods

Course Outcomes:

The student will be able to

1. understand the principles of atomic spectroscopy
2. realize the importance of IR and Raman Spectroscopy
3. apply the principles of electronic spectroscopy
4. understand the principles of NMR spectroscopy
5. realize the importance of radiochemical methods in forensic science
6. utilize the role of electrochemical methods in forensic science

Unit 1: Basic Concept of Atomic Spectroscopy (10 Hours)

Electromagnetic spectrum, various source of radiation their utility and limitation. Interaction of radiation with matter - Detection of radiation - Forensic application of spectroscopy - Atomic Spectrometry – General properties of Electromagnetic Radiation – Optical Atomic Spectra – Principles, instrumentation, techniques and forensic applications of Atomic Absorption and Atomic Fluorescence Spectrometry – Atomic Emission Spectrometry – Atomic Mass Spectrometry - Atomic X-Ray Spectrometry

Unit 2: Principles of UV-Visible Spectroscopy (9 Hours)

Molecular Spectroscopy – Introduction to UV-Visible Spectroscopy –Measurement of Transmittance and Absorbance – Beer's Law – Instrumentation– Molar Absorptivities – Absorbing Species – Application to Qualitative Analysis – Quantitative Analysis – Photometric Titrations – Photoacoustic Spectroscopy – Molecular Luminescence Spectroscopy– Theory of Fluorescence and Phosphorescence – Instrumentation – Applications of Photoluminescence methods –Chemiluminescence

Unit 3: Principles of IR and Raman Spectroscopy (9 Hours)

Infrared Spectroscopy– Theory – Infrared Sources and Transducers – Instrumentation –Dispersive and FT instruments - Techniques and Applications – Mid IR Absorption, Mid IR Reflection and Photoacoustic IR Spectroscopy – Near and Far IR Spectroscopy – IR Micro Spectroscopy – Forensic Applications of IR Spectroscopic methods- Raman Spectroscopy – Principles – Instrumentation – Techniques - Applications

Unit 4: Principles of NMR Spectroscopy (8 Hours)

Nuclear Magnetic Resonance Spectrometry – Principles, Instrumentation, Techniques (Proton NMR,Carbon13 NMR, FT- NMR, Magnetic Resonance Imaging) and Forensic Applications

Unit 5: Radiochemical methods and Thermal methods (9 Hours)

Radiochemical Methods – Radioactive Isotopes - Principles, Instrumentation, Techniques and Application of Neutron Activation Analysis and Isotope Dilution Methods -Application of radiochemical techniques in forensic science - Electrochemical techniques: General principles Electron transport process, Principles, instrumentation, techniques and applications of Conductometry, potentiometry, coulometry, polarography and ion selective electrodes

Text Books:

1. P.W. Atkins, "Physical Chemistry", 8th edition, Oxford University Press, 2006
2. Barrow, G. M, "Introduction to Molecular Spectroscopy", McGraw-Hill Inc., USA, 1988 ISBN-10: 0070038708, ISBN-13: 978-0070038707
3. Haswell, S. J." Atomic Absorption Spectrometry", Elsevier, 1991.ISBN:9780444882172
4. R. M. Silverstein, F. X. Webster, D. J. Kiemle, "Spectrometric identification of organic compounds", 7th edition, John Wiley, 2005.
5. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd", New Delhi, India, 8th Edition, 2004.
6. Day R. A.& Underwood A. L., "Quantitative Analysis", 6th Edition, Printice Hall of India Pvt Ltd, New Delhi,2006.

7. James W. Robinson, "Atomic Spectroscopy, 2nd Edn. Revised & Expanded, Marcel Dekkar, Inc, NY. (1996)
8. K.C. Thompson & R.J. Renolds, "Atomic Absorption Fluorescence & Flame Emission Spectroscopy, A Practical Approach, 2nd Edn. Charles Griffin & Co. (178)
9. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributers Pvt. Ltd, New Delhi, 7th edition, 1998
10. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
11. Christian G.D, "Analytical Chemistry" John Wiley & Sons, 6th Edition, 2004
12. U.N. Dash, "Analytical Chemistry: Theory and Practice". Sultan Chand and sons Educational Publishers, New Delhi, 2013, ISBN-10: 8180549534 ISBN-13: 978-8180549533
13. Fifield, F. W. and Kealy, D. " Principles and practice of Analytical Chemistry", 5th Edition, Blackwell Science Ltd, 2000, ISBN 0-632-05384-4
14. Subramanian P.S. Gopalan R., Rangarajan K. "Elements of Analytical Chemistry", S. Chand and Co., New Delhi, 2003. ISBN-10: 8180547655; ISBN-13: 978-8180547652
15. Gurdeep R. *Chatwal* and Sham K. *Anand*, "*Instrumental Methods of Chemical Analysis*", 5th edition, Himalays*Publishing House, 2018.*
16. Gowenlock, A. H.: Varleys, "Practical Clinical Biochemistry", 6th Edition, CBC, 2006, ISBN-10: 9788123904276; ISBN-13: 978-8123904276
17. Kealey, D. and Haines, P. J.: BIOS Instant Notes in Analytical Chemistry", Taylor & Francis, 2002, ISBN-10: 1859961894; ISBN-13: 978-18599618962002.
18. Lajunan, L. H. J. "Spectrochemical Analysis by Atomic Absorption and Emission", Royal Society of Chemistry; 2005, ISBN-10: 0854046240 ISBN-13: 978-0854046249
19. Lundquist & Curry (1963) Methods of Forensic Science.
20. Moonesens A.A. (1979) Scientific Evidence in Criminal Cases.
21. Nad, A. K., Mahapatra, B. and Ghoshal, A., "An Advanced Course in Practical Chemistry", New Central Book Agency, 2000.
22. Sane, R.T. and Joshi, A.P., "Electroanalytical Chemistry: Theory and Applications",Quest Publications. 1999
23. F.A. Settle, "Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, 1997.
24. Sharma, B. K. "Instrumental Methods of Chemical Analysis', Krishna Prakashan Media p Ltd; 2011, ISBN-10: 8182830990; ISBN-13: 978-8182830998
25. Verma, R. M. "Analytical Chemistry, Theory and Practice, 3rd edn, CBS, 1994
26. Paul Worsfold Alan Townshend Colin Poole Manuel Miró, "Encyclopedia of Analytical Science" 3rd Edition, Elsevier, 2019, ISBN: 9780081019832

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		1	2				1	1	
CO2	2	1		1	2		1	2		1
CO3	1		2			1		2	1	
CO4	2	2	1		3		2	1	2	
CO5	1			2	1		2	2		1
CO6	2		1		2	1	1		2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3047	Advanced Forensic Toxicology and Pharmacology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the basic concepts of toxicology
2. Learn the methods involved in toxicological analysis
3. Understand the pathways of drug metabolism

Course Outcomes:

The student will be able to

1. understand the various types of poisoning
2. understand the principles of toxicology
3. summarize the methods involved in toxicological analysis
4. understand the methods involved in elimination of poisons
5. know the pathways of drug metabolism
6. summarize the types of vegetable poison

Unit 1: Introduction to Toxicology (9 Hours)

Toxicology- Introduction- History- Scope- Areas of Toxicology- Role of forensic toxicologist- Poisons- Classification of poisons- Types of poisoning- Sample collection and preservation of toxicological exhibits in fatal and survival cases- Storage of samples- Signs and symptoms of poisoning- Toxicological investigation of poisoned death- Interpretation of toxicological data- Courtroom testimony in toxicological cases. Case Histories

Unit 2: Principles to Toxicology (9 Hours)

Introduction – Pharmacokinetics - Methods of transportation of toxicant-Absorption- Distribution- Storage of toxicants- Redistribution - Metabolism-Oxidation – Reduction –Hydrolysis – Conjugation - Excretion- Other routes of elimination- Toxicokinetics- one and two compartmental model – Toxicodynamics- Spectrum of undesired (toxic) effects- Interaction of chemicals-Tolerance- Dose response relationship- Developmental and reproductive toxicity- Mutagenicity- Toxicity testing

Unit 3: Toxicological Analysis (9 Hours)

Introduction- Sample preparation – Deproteinization – Deconjugation - Liquid–liquid, solid phase, supercritical fluid extraction methods, Isolation and Clean-up procedures intoxicological analysis- Identification and quantitation of poisons by physical, chemical, chromatographic,spectrophotometric, electrophoretic, immunoassay- and other methods (Metals, anions, volatile poisons,gases, drugs, pesticides and miscellaneous poisons) - Field testing in toxicological work – Therapeuticdrug monitoring – Emergency hospital toxicology

Unit 4: Management of acute poisoning (9 Hours)

Introduction- Maintenance of vital functions- Measures to enhance elimination of poisons- Removal of unabsorbed poisons- Antidotes- Classification of antidotes-Mechanism of action of antidote – Examples - Identifying route of administration of poison- Estimation of time and doseafter administration of poison- Recovery and after care of patients- Poison Information/Control Centre.

Unit 5: Forensic Pharmacological studies (9 Hours)

Absorption, Distribution, Metabolism, Pathways of drug metabolism -General studies and Analysis of some vegetable poisons, Opium, Abrus, Cynanogenetic glycosides, Dhatura, Marking nuts, Nux-vomica, Oleander and Aconite

Textbooks:

1. Klaassen, C. D.,:Casarett and Doull's Toxicology: The Basic Science of Poisons, 5th edition, 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,m2000.
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., NiralimPrakashan,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.,mA.I.T.B.S, 2002
9. Hardman, J. G. and Limbird, L. E.,: Goodman and Gilman's The Pharmacological basis ofmTherapeutics, 9th edn., McGraw-Hill, 1996
10. Laboratory procedure Manual, Forensic Toxicology: DFS, 2005
11. Sunshine, I ; Methods for Analytical Toxicology, CRC Presss 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 Organs
18. Levine Barry, Principles of Forensic Toxicology, 2nd Edn., (2006)
19. Hodgeon Emeet, A Text Book of Modern Toxicology, 3rd.Edn. (2004)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2		2	1		1	2	1
CO2	3	2		1			1	2		2
CO3	2	1			2			2	1	
CO4	2		2	2		1	1	1	2	
CO5	2	1					1	1	2	
CO6	1		1		2	1		2	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3048	Instrumental Methods of Analysis - II	L 3	T 0	P 0	C 3

Course Objectives:

Enable the student to

1. Understand the basic principles of chromatography
2. learn the principles of mass spectrometry and hyphenated techniques
3. understand the use of microscopic techniques and thermalmethods

Course Outcomes:

The student will be able to

1. summarize the types of chromatographic techniques
2. realize the importance of High Performance Liquid Chromatography
3. apply the principles of mass spectrometry in forensic science
4. realize the importance of hyphenated techniques
5. realize the use of microscopic techniques in forensic science
6. utilize the role of X-ray diffraction techniques in forensic science

Unit 1: Principles of Chromatography (9 Hours)

Chromatographic Techniques – Introduction - Theoretical principles– Classification of– Adsorption and Partition Chromatography - Principles, instrumentation, techniques and applications of Thin Layer Chromatography - Method Development in Planar Chromatography – GasChromatography – Instrumentation – Detectors - Adsorption, Partition, Gas-Solid, Gas-Liquid, Isothermal, Linear Temperature Programming, Chiral, Pyrolysis and Derivatization Chromatography -Columns and Stationary Phases – Column Efficiency – Method Development - Forensic Applications of Gas Chromatography

Unit 2: High Performance Liquid Chromatography (9 Hours)

High Performance Liquid Chromatography – Instrumentation - Detectors – Columns and Stationary Phases - Isocratic, Gradient, Adsorption, Partition, Ion and Derivatization Chromatography – Method Development – Applications of Liquid Chromatography - Super Critical Fluid Chromatography – Properties of Super Critical Fluids – Instrumentation – Columns – Detectors – Applications – Capillaryelectrophoresis – Principles, instrumentation, technique and applications

Unit 3: Mass Spectrometry (8 Hours)

Principle and Instrumentation - Correlation of MS with molecular structure -Interpretation of mass spectra – Applications of mass spectrometry – Atomic mass spectrometry – Mass spectrometers – Inductively coupled plasma-Mass spectrometry. Application of MS in Forensic Science

Unit 4: Hyphenated techniques (8 Hours)

Unit Measurements, signals and data – Introduction – Signal to noise ratio – Sensitivity and detectionlimit, sources of noise – Evaluation and measurement – Accuracy and instrument calibration Hyphenated techniques – Principle, instrumentation, techniques and applications of GC-FTIR, GC-MS, LC-MS, CE-MS and MS-MS.

Unit 5: Other Techniques (10 Hours)

Microscopy: Theory and basic principles, setup and Forensic applications of Compound, Comparison,Fluorescence, Polarized, Stereo-zoom microscope. Electron Microscopy- Theory and basic principles of Electron Microscopy, Structure and Forensic applications of Scanning Electron microscope (SEM), Transmission Electron Microscope (TEM). -X-Ray diffractometry – Principle, instrumentation, techniques and applications -Thermal Methods – Principles, Instrumentation, Techniques and Applications of: Thermo gravimetric methods – Differential Thermal Analysis – Differential Scanning Calorimetry

Textbooks:

1. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
2. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributers Pvt. Ltd, New Delhi, 7th edition, 1998
3. Kealey, D. and Haines, P. J.: BIOS Instant Notes in Analytical Chemistry, Taylor & Francis, 2002, ISBN-10: 1859961894; ISBN-13: 978-18599618962002.
4. Settle, F. A.: Hand Book of Instrumental Techniques for Analytical Chemistry, Prentice Hall,1997.
5. Harris, D. C.: Quantitative Chemical Analysis, 5th edn., Freeman, 1999
6. Sane, R. T and Ghadge, J. K:Thermal Analysis, Theory and Applications, Quest Pub.,Mumbai, 1997
7. Christian, G. D.: Analytical Chemistry, Theory and Applications, John Wiley, 2004
8. Sharma, B. K.: Instrumental Methods of Chemical Analysis, Krishna Prakashan Media (P) Ltd, India, 2014
9. Townsends Allen (ed.): Encyclopedia of Analytical Science, Academic Press, 1995
10. Goldsby, R. A., Kindt, T. J., Osborne, B. A and Kuby, J: Immunology, 5th Edn., Freeman, 2003.
11. Mukherjee, K. L (Ch. Ed): Medical Laboratory Technology, Vol I & II, Tata McGraw-Hill, 1988.
12. Gerstein, A.S (Ed): Molecular Biology - Problem Solver – A Laboratory Guide, Wiley- Liss, 2001
13. Jarris, K.E., A.L. Gray & R.S. Hock, EDS; handbook of Inductively Coupled Plasma Mass Spectrometry; Glasgow Blockie, (1992)
14. Maclaffrty, F.W. & F. Turecek; Interpretation of Mass spectra; 4th ed Mill Valley, C A Univ. Science Books, (1993)
15. Chapmen, J.R.; Practical Organic Mass spectrometry, A Guide for Chemical and Biochemical Analysis, Wiley, New York, (1993)
16. Lindsay, S.; High Performance Liquid Chromatography, New York, Wiley (1992)
17. Gurdeep R. *Chatwal* and Sham K. *Anand*, *Instrumental Methods of Chemical Analysis*, 5th edition, Himalays*Publishing House, 2018.*
18. Egon Stahl, Thin-Layer Chromatography: A Laboratory Handbook, CBS Publishers abnd distributors, 2005
19. Fried Bernard, Thin-Layer Chromatography, Revised And Expanded, Taylor & Francis Inc
20. Vk Srivastava, Kk Srivastava, "Introduction To Chromatography Theory & Practice", 4th EditionS Chand & Company Pvt Ltd, 1991
21. Robert M. Silverstein & Francis X Webster; Spectrometric Identification of Organic Compounds, 6th Edn., John Wiley & Sons, Inc. (1997)
22. P.S. Kalsi; Spectroscopy of Organic Compounds, 4th Edn, New Age International Pub. (2001) w.e.f. 2005-2006
23. R.S. Khandpur; handbook of Analytical Instruments, Tata McGraw Hill Pub. Co. New Delhi (2004)
24. John A. Dean; Analytical Chemistry Handbook, McGraw Hill Inc. (1995)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3		2		1	2		1	1	1
CO2	2	3		2	2			2	3	
CO3	2	2	1	2		3	1	1		2
CO4	3		2	1	1		1	1		
CO5	2	2	1		2		1		2	
CO6	2		2	1		2		2	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3049	Forensic Chemistry Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. detect the liquors and corrosive chemicals
2. Detect the drugs
3. Detect the explosives

Course Outcomes:

The student will be able to

1. Understand the importance of detection of drugs
2. Apply the knowledge to detect inorganic explosives
3. Apply the knowledge to detect organic explosives
4. Find the melting point of various substances
5. Analyze corrosive chemicals
6. Analyze dyes and pigments

LIST OF EXPERIMENTS

1. Detection of methanol, chloral hydrate and alprazolam in alcoholic liquors
2. Extraction and detection of inorganic explosive / explosion residues by spot tests
3. Extraction and detection of inorganic explosive / explosion residues by colour tests
4. Extraction and detection of organic explosive / explosion residues by spot tests
5. Extraction and detection of organic explosive / explosion residues by colour tests and TLC
6. Analysis of Phenolphthalein in trap cases.
7. Analysis of forensically important cosmetics
8. Analysis of Dyes, Pigments & Polymers
9. Forensic analysis of oils and fats
10. Analysis of chemical fertilizers, consumer items such as gold, silver, tobacco, tea, sugar, salts,
11. Analysis of Corrosive chemicals: Hydrochloric acid, sulphuric acid, and nitric acid and alkalis.
12. Detection of Narcotic Drugs and Psychotropic Substances (NDPS) eg. Opiates, barbiturates,benzodiazepines, amphetamines and cannabis by spot / colour tests.
13. Chemical analysis of liquors.
14. Forensic Drug Testingby Color/spot test, Microcrystalline testing
15. Melting Point determination of some substances of forensic interest.
16. Forensic investigation of arson scene of crime.
17. Forensic analysis of arson related evidences.
18. Characterization and analysis of adulteration of Petroleum products.
19. Bomb scene investigation
20. Systematic analytical approach to pre-blast and post-blast explosives
21. Examination of a bribe trap case

(Minimum 10 experiments to be completed)

Text Books:

1. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
2. Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
3. Frank Lundquist, MethodsofForensic Science, Vol. 1, New York, Interscience, 1962.

4. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.

20CH3050	Forensic Tools and Techniques Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Understand the importance of analytical chemistry
2. Realize the use of qualitative analysis
3. Realize the importance of quantitative analysis

Course Outcomes:

The student will be able to

1. Understand the importance of accuracy
2. Realize the importance of qualitative inorganic analysis
3. Apply the organic qualitative analysis
4. Practice volumetric analysis
5. Apply gravimetric method of analysis
6. Apply various separation techniques

LIST OF EXPERIMENTS

1. Work out the problems related to mean, median, mode, standard deviation, probability, Chi-square test, t-test and correlation
2. Familiarize the technique of data representation (tables, bar-diagram, histogram, pie- diagram and frequency curve, manual and using computer)
3. Qualitative analysis of Lead, Arsenic, Chromium, Zinc, Selenium, Thallium,
4. Qualitative analysis of Cyanide, Thiocyanate,Phosphate, Chlorate, Perchlorate ions in compounds
5. Detection of non nitrogenous and nitrogenous functional groups in organic compounds
6. Partition coefficient of benzoic acid between benzene and water
7. Determination of sodium carbonate and sodium bicarbonate in a mixture with standard HCl
8. Determination of purity of potassium /sodium nitrite by permanganometry
9. Estimation of ferric iron in ferric alum by dichromatometry
10. Estimation of lead by iodimetry
11. Estimation of calcium and magnesium by EDTA complexometry
12. Preparation of buffer mixtures and measurement of pH
13. Study of hydrolysis of an ester catalysed by an acid
14. To determine the concentration of a colored compound by colorimetry analysis

(Minimum 10 experiments to be completed)

Text Books:

1. Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
2. Frank Lundquist, MethodsofForensic Science, Vol. 1, New York, Interscience, 1962.
3. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
5. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
6. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
7. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008

20CH3051	Forensic Toxicology Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Understand the methods of detecting poisons

2. Understand the estimation of poisonous substances
3. Extract the substances systematically

Course Outcomes:

The student will be able to

1. Understand the methods of extraction of poisons
2. Apply the methods to separate insecticides and pesticides
3. Identify the poisons microscopically
4. Analyze the poisonous substances
5. Identify various types of drugs
6. Determine the amount of drug or pesticide in a speciman

LIST OF EXPERIMENTS

1. Extracting poisons from viscera/blood and urine samples.
2. TLC separation of pesticides/insecticides & Identification using chromomeric reagents
3. Lab testing of Aluminum Phosphide (Phosphine gas)
4. Identification of Gaseous Poisoning (Carbon Monoxide and HCN)
5. Detection of metallic poisons using Reinsch Test.
6. Extraction and analysis of different categories of poisons from viscera.
7. Estimation alcohol in Blood.
8. Microscopic Identification of plant poisons.
9. Analysis of viscera and food material for in case of food poisoning by chemical microscopic and instrumentaltechniques.
10. Qualitative Descriptions of Toxicity Exposure Limits Determination of LD50 and ED50, Units in Toxicology.
11. Preliminary tests directly on blood / urine / vomitus / tissues for heavy metals, alkaloids, pesticides,cyanide, phenolic compounds and alcohol
12. Detection and determination of ethyl alcohol in blood / urine / visceral tissue by kozelka& Hine'smethod
13. Detection and determination of ethyl alcohol in blood / urine / visceral tissue by gas chromatography
14. Systematic extraction of basic substances from viscera
15. Systematic extraction of neutral & acidic substances from viscera

(Minimum 10 experiments to be completed)

Textbooks:

1. Curtis D. Klaassen, "Casarett&Doull's Toxicology: The Basic Science of Poisons" 9th edition, McGraw-Hill Education, 2019
2. "Clarke's isolation and identification of drugs",edited by A. C. Moffatt., 2nd Edition, Pharmaceutical Press: London. 1986.
3. Curry A.S, "Analytical Methods in Human Toxicology, Part II" CRC Press, Ohio,1986.
4. Curry A. S., "Poison detection in human organs (American lecture series)", Thomas Publishers, 1976.
5. CRC Handbook of Toxicology, Edited by M. J. Derelanko and M. A. Hollinger, CRC Press, 1995.
7. Morgan B.J.T, "Statistics in Toxicology" Clarendon Press, Oxford.1996
8. Modi,"Text Book of Medical Jurisprudence Forensic Medicines and Toxicology" CBS Pub. New Delhi, 1999
9. Saferstein. R, "Forensic Science Handbook", Volumes I, II and III, 2nd edition, Pearson, 2001
10. DFS Manual of Forensic Toxicology
11. Moffat, A. C,Osselton, M. D, Widdop, B and Watts, J, "Clarke's Analysis of Drugs and Poisons"Fourth edition, Pharmaceutical Press: London. 2011

20CH3052	Instrumental Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Understand the importance of spectroscopic techniques
2. Realize the use of conductometric analysis
3. Realize the importance of potentiometry

Course Outcomes:

The student will be able to

1. Understand the applications of Lambert-Beer Law
2. Realize the importance of spectroscopic methods of analysis
3. Use spectroscopic techniques for the identification ofdrugs
4. Analyze the sample using IR spectroscopy
5. Understand the importance of conductometrictitration techniques
6. Apply potentiometric titration

LIST OF EXPERIMENTS

1. Verification of Beer's law and calculation of molar absorption coefficients for CuSO4
2. Verification of Beer's law and calculation of molar absorption coefficients for KMnO4
3. To identify drug samples using UV – visible spectroscopy
4. Determination of a drug in urine by visible / UV spectrophotometry
5. IR spectroscopy of samples of forensic interest -1
6. IR spectroscopy of samples of forensic interest -2
7. Conductometric titration of weak acid vs. strong base
8. Conductometric titration of strong acid vs. strong base
9. Conductometric titration of mixture of acids vs. strong base
10. Potentiometric redox titration of potassium dichromate-ferric ammonium sulphate
11. Potentiometric titration -2
12. Potentiometric titration – 3

(Minimum 10 experiments to be completed)

Text Books:

1. Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
2. Frank Lundquist, MethodsofForensic Science, Vol. 1, New York, Interscience, 1962.
3. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
5. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
6. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
7. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India,

20CH3053	Modern Instrumental Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand experiments based on chromatography
2. realize the importance of chromatographic techniques for separation
3. Analyze the SEM photograph

Course Outcomes:

The student will be able to

1. Utilize color test for the identification of drugs
2. Use TLC for the identification of drugs
3. Use TLC for the identification of prsticides
4. Apply GC technique for the identification of drug
5. Understand the use of HPLC in forensic science
6. Analyze the SEM photograph

LIST OF EXPERIMENTS

1. Identification of basic drugs (from the extract) by colour tests and TLC -1
2. Identification of basic drugs (from the extract) by colour tests and TLC -2
3. Identification of neutral and acidic drugs (from the extract) by colour tests and TLC -1
4. Identification of neutral and acidic drugs (from the extract) by colour tests and TLC -2
5. Identification of pesticides (from the extract) by TLC
6. Detection of (NDPS) by TLC
7. Determination of a drug / pesticide in toxicological specimen by GC -1
8. Determination of a drug / pesticide in toxicological specimen by GC -2
9. Determination of a drug / pesticide in toxicological specimen by HPLC
10. GC-MS / LC-MS of a poison of forensic interest (Demo only)
11. Determination of a drug of forensic interest by GC
12. Determination of a drug / explosive of forensic interest by HPLC
13. SEM Analysis-1(Metal fragment/Hair/Fiber/Paint/Ink)
14. SEM Analysis-2(Metal fragment/Hair/Fiber/Paint/Ink)

(Minimum 10 experiments to be completed)

Text Books:

1. Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
2. Frank Lundquist, MethodsofForensic Science, Vol. 1, New York, Interscience, 1962.
3. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
5. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
6. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
7. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India,

20CH3054	Biochemistry and Biochemical Applications	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the basic concepts of biochemistry
2. Learn the role of biomolecules
3. Understand the importance of electrophoresis

Course Outcomes:

The student will be able to

1. understand the various types of biomolecules
2. understand the importance of Aminoacids
3. summarize the composition ofproteins
4. understand the enzyme action
5. know the role of nucleic acids
6. summarize the principles of electrophoresis

Unit 1: Proteins and peptides (9 Hours)

Biomolecules and cells – Biological fitness of organic compounds – Hierarchy of molecular organization of cells – Primordial biomolecules – Specialization and differentiation of biomolecules- The dimensions and shapes of biomolecules- Biomolecules supra molecular structures and cell organelles- Structural organization of cells. Proteins and peptides – Composition of proteins – Size of protein molecules – Confirmation of protein supra molecular assemblies of proteins – Denaturation – Estimation of proteins Functional diversity of proteins – Antibodies and immune response – The species specificity of proteins – Sequence isomerism in polypeptide chains – Genetic coding of amino acid sequences in proteins- Mutation – Structure of peptides – Optical and chemical properties of peptides- Steps in determination of amino acid sequence – Separation and analysis of peptides – Sequence analysis of peptide fragments.

Unit 2: Amino acids (9 Hours)

Amino acids – Common amino acids of proteins – Rare amino acids of proteins – Non protein amino acids- Physicochemical properties of amino acids – Absorption spectra of amino acids – Chemical reactions of amino acids – Analysis of amino acid mixtures – Complete hydrolysis of polypeptide chains and determination of amino acid composition – Identification of N-terminal and C-terminal residues of peptides.

Unit 3: Enzymes (9 Hours)

Enzymes – Definition, types and classification - Biological activities – Kinetics – Inhibition - Types of inhibition - Poisoning – Micheles-Mentor's equation – Enzyme polymorphism – Purification of proteins and enzymes – Enzyme assay techniques: UV-Vis, Luminescence, Radio isotope and immunochemical methods – Automated enzyme analysis – Immobilized enzymes.

Unit 4: Nucleic Acids (9 Hours)

Nucleotides – General structure of the nucleotides – Pyrimidines and purines – Nucleosides, Nucleotides – Nucleic acids – RNA and DNA - Short hand representation of nucleic acid back bones- Hydrolysis of nucleic acids by acids and bases – Enzymatic hydrolysis of nucleic acids – Analysis of nucleotide sequence in nucleic acids – Nucleic acid- Protein supra molecular complexes – DNA sequencing – PCR technique

Unit 5: Electrophoresis (9 Hours)

Electrophoretic Techniques – Overview of Electrophoresis – Principles – Classification of electrophoresis - Factors affecting migration – Instrumentation, Techniques and Applications of: Zone Electrophoresis – Cellulose Acetate Membrane Electrophoresis – Agar Gel Electrophoresis – Acryl amide Gel Electrophoresis – Capillary electrophoresis -Isoelectric Focusing – Isotachophoresis – Biochemical techniques – General principles – pH and buffers – physiological solution – Cell and tissue culture – Cell fractionation –DNAProfiling Techniques: PCR, RFLP etc. Centrifugation techniques- Forensic Application of electrophoresis,

Textbooks:

1. Nelson, D. L., and Cox, M. M., "Lehninger Principles of Biochemistry", 3rd edition., Macmillan Worth, 2000
2. Voet, D. and Voet, J.G., "Biochemistry", 2nd edition, John Wiley, 1995
3. Rao, P. Gundu, "Biochemistry",VallabhPrakashan, 1995
4. White, A., Handler, P. and Smith, E., "Principles of Biochemistry", 5th Edition, McGraw-Hill Kogakusha Ltd, 1973
5. Turner, P.C, McLennan, A. G., Bates, A. D., and White, M. R. H., "Molecular Biology", 2nd edition. BioScientific/Viva Books, 2001.
6. Rao, Rama. A. V. S. S., " A Text Book of Biochemistry", 8th editionn., L. K & S Pub,1998
7. Henry, B. J., "Clinical Diagnosis and Management by Laboratory Methods", 19th edition., Harcourt / Thomson,1999.
8. Gowenlock, A. H., "Practical Clinical Biochemistry", 6th edition., Butterworth / CBS, 1988
9. Plummer, D. T., "An Introduction to Practical Biochemistry", 15th edition, Tata McGraw Hill,1988.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2		3	1	1		2	1	2
CO2	2	1	2		2	2		2	2	
CO3	3		2	2	1	2	1	1		2
CO4	3	2	1	2			1	1	2	
CO5	2		2	1		1	2	2	2	
CO6		2	2	1		2	2	1	2	2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3055	Standards, Quality Management, Laboratory Management and Safety	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand about various standards used

2. know about the laboratory management and quality management
3. apply the steps to be taken for laboratory safety

Course Outcomes:

The student will be able to

1. summarize various chemical standards
2. Summarize various biological standards
3. Understand about the quality management systems
4. Realize the importance of Laboratory Management
5. understand Laboratory Information Management system
6. apply the steps to maintain Laboratory safety

Unit 1: Standards for analysis (9 Hours)

Basic standards – Need of standards is analytical sciences – Basic chemical standards – Analytical standards – Reference materials – High purity substances – Certified reference materials – Working or secondary standards – Matrix effect in standards – Biological standards – Biochemical standards – Microbial cell lines and standards

Unit 2:Quality Management (9 Hours)

Introduction – Quality - Quality system – Quality plan – Inspection and testing – Test records – Control of inspection - Handling, storage, packaging, preservation and delivery of the material – Control of quality records – Internal quality audits – Quality assurance – Training Laboratory Accreditation – ISO 9000 - ISO 14000 and 17000 series of standards – Accreditation Boards – NABL guidelines for accreditation in India Proficiency testing system – Internal quality control – Inter and intra laboratory testing programmes – Designing and running the proficiency testing programmes – Confidentiality - Advantages of accreditation

Unit 3: Laboratory Management (9 Hours)

Administration of Laboratories – Types of laboratories – Connection between filed work and laboratory – Educational requirements of laboratory personnel – Routine laboratory work – Research and development – Internal organization of a laboratory Architectural requirements – Laboratory design – Floor area - Furniture design – Auxiliary services – Receipt of reports and remnants – Record management – Requirement of equipment, glassware, chemicals and other material – Purchase procedure – Disposal of wastes – Security of the premises

Unit 4:Laboratory Information Management system (LIMS) (9 Hours)

Classification of LIMS - Functions – Sub-division by functional area – Definition of LIMS – Strategic design of LIMS – System development life cycle – Review of the laboratory – Project proposal – Definition of system requirements – Specifications – Commercial or Bespoke LIMS – Evaluation – Purchase and installation – Demonstration – Validation – User training and implementation

Unit V: Laboratory Safety (9 Hours)

Planning – Written safety plan – Safety policies – Safety resources – Operations - Hazards of chemicals, solvents, poisons and explosives – Storage facilities – Biological hazards - Pressure vessels and then handling – Electrical safety – Fume cup boards-Exhausts system – Protective equipment - Emergency care and medical facilities

Textbooks

1. 1.Woodget, B. W. and Cooper, D., “Sample and Standards”, ACOL Series, Wiley, 1987
2. Dux, J. P., “Hand Book of Quality Assurance for Analytical Chemistry Laboratory”, Van Nostrand, 1986
3. Duncan, W. L and International, L.W, "Total Quality: Key Terms and Concepts" AMACOM publishers, 1995
4. Shah, D. H., “QA Manual”, Business Horizons, 2000
5. Kumar, K., “Quality Management”, ABD Pub., 2000
6. Ross, J., “Total Quality Management”, Vanity Book, Intl., 1995
7. Seiler, J. P., “Good Laboratory practice”, Springer, 2000
8. Diwan, P., “Quality in Totality, Manager’s Guide to TQM and ISO 9000”, Deepti&Deepti Pub., 2000
9. Gyani, G. J. “Training Manual on ISO 9000; 2000 and TQM”, Raj Pub., 1999
10. Olson, M. H. and Davis, G. B., “Management Information Systems” McGraw Hill, 1998

11. Specific Guidelines for Accreditation of Forensic Science Laboratories, DST, 1998
12. "Guide for Safety in The Chemical Laboratory:",Manufacturing Chemist's Association, 2nd Edition, 1972
13. Steere N. V.(Ed.), "Hand Book of Laboratory Safety", CRC, 1967
14. Tilstone, W. J. and Lothridge, K., "Crime Laboratory Management", Taylor and Francis, 2004
15. Clair, J. S, "Crime Laboratory Management", Academic Press, 2003
16. Siegel, J. A, Saukko, P. J and Knupfer, G. C (Eds.), "Encyclopedia of Forensic Sciences", Academic Press, 2000

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3		2			2		1	2	
CO2	2	1		2	1		1	1	1	
CO3	3	2	1			2		1	2	
CO4	3	1		2	2	1	1	2	1	1
CO5	2	2	2		1	2	2	2	1	3
CO6	2	3	1		2		2	1	2	3

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3056	IPR, Ethics and Research Methodology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand about IPR
2. know about the research ethics
3. apply the steps to be taken in research methodology

Course Outcomes:

The student will be able to

1. realize the importance of IPR
2. apply the ethics to be carried out in research
3. summarize the steps in research methodology
4. differentiate basic research and applied research
5. design experiments
6. follow the research progress

Unit 1: Intellectual Property Rights (9 Hours)

Meaning,- Evolution – Classification and forms – Rationale for protection of IPRs – Importance of IPRs in the fields of science and technology – Patents – Concepts and principles of patenting – Patentable subject matter – Procedure of obtaining patents – Rights of patents — Patentability and emerging issues. Role of WIPO – PCT.

Unit 2: Ethical Issues(9 Hours)

Introduction – Causes of unethical acts – Ignorance of laws, codes, policies and procedures – Recognition – Friendship – Personal gain - Professional ethics – Professional conduct - Ethical decision making – Ethical dilemmas - Teaching ethical values to scientists – Forensic Science ethics and Personal ethics – Organizational Forensic Science Ethics – Code of ethics in Forensic Science practice – Standards for good forensic practice - Good laboratory practices (GLP) – Good manufacturing practices (GMP).

Unit 3: Research methodology(9 Hours)

Introduction – Basic research – Applied research – Need based research –Keywords and its significance- Literature search -— Information sources – Library resources – Reference Books, Journals, abstracts, hand books, procedure manuals, encyclopedias, annual reports, data banks, CDROMS and online literature search – Internet access, websites and directories of information resources - Identification of the Research problem – Research project planning.

Unit 4: Design of Experiments (9 Hours)

Design of the experimental programme –Variables in the experiments – Materials and methods – Evolution of method –Application of the method – Reproducibility – Report of research findings.

Unit 5: Research Progress (9 Hours)

Progress of research – Evaluation of results – Statistical approach – Comparison with existing methodologies – Validation of findings – Research communications – Plagiarism - Research ethics- Impact factors of journals

Suggested reading:

1. American Academy of Forensic Sciences: Code of Ethics and Conduct, Colorado Springs, 1998
2. Chadwick, R: Concise Encyclopedia of the Ethics of New Technologies, Academic Press, 2001
3. Siegel, J. A, Saukko, P. J and Knupfer, G. C (Eds.): Encyclopedia of Forensic Sciences, Academic Press, 2000.
4. IPO Intellectual property handbook, WIPO Publication no. 489 (E) ISBN 978-92-805-1291-5, WIPO 2004 Second Edition Reprinted 2008.
5. Patent IPR Licensing- Technology Commercialisation – Innovation Marketing,ByIndian Innovators Association, Notion Press, ISBN: 978-1-947851-43-6.

	PO 1	PO2	PO 3	PO4	PO5	PO 6	PO7	PSO1	PSO 2	PSO 3
CO1	2	1	1		2	1		1	1	
CO2	3	2		2	1		1	1	1	
CO3	3	2	2	1		2		2	2	
CO4	2		3	2	2			1	2	3
CO5	2	1	3	2		1	2		2	3
CO6	3	3	2	1	2		2	2	2	2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3057	Forensic Analysis of Drugs	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Learn about the drug and drug abuse
2. Understand the problems of Clandestine laboratory
3. Summarize the drugs used in sports

Course Outcomes:

The student will be able to

1. understand about drug
2. summarize the illegal drugs
3. understand the chemistry of drugs
4. understand the methods of analysis of drugs
5. realize the problems of Clandestine laboratory
6. summarize the drug abuse in sports

Unit 1: Drug (9 Hours)

Definition of Drug, Drug Use & Misuse, Drug Chemistry, Drug Dependence and chemistry of Addiction, Drug Receptors and Brain Chemistry. Drugs of Abuse: Definition, Classification based on Form and Origin, Use, Effects and Schedules, Structure of NDPS Act and the definitions of each drug classification, Drugs as Evidence, Profiling Examples of Illegal Drugs, United Nations International Drug Control Programme.

Unit 2: Chemistry and Analysis of Drugs of Abuse (9 Hours)

Origin, Pharmacology, Methods of preparation, Storage, Diluents and Adulterants, Sample Handling, Optimization of Experimental Conditions, Presumptive/Screening and Confirmatory Methods - Legal Implications and Data Interpretation of Opium and Opioids analgesics, Stimulants (Cocaine, Amphetamine & other amphetamine derivatives), Depressants (Barbiturates and Benzodiazepines), Hallucinogens (Cannabis, LSD, Psilocybine and Mescaline), OTC, Inhalant and Volatile Substances, Drugs in sexual assault

Unit 3: Clandestine laboratory (9 Hours)

Meaning and Definition of Clandestine, Clandestine Laboratory, Related Problems, Factors Contributing to Clandestine Drug Labs, Harms Caused by Clandestine Drug Labs, Equipment Needs: Reflux, Distillation, Hydrogenation, Bucket Chemistry, Extractions, Chemical Needs, Cooking Methods

Commonly Used in Clandestine Drug Labs, Extraction Process, Conversion Process, Synthesis Process, Tableting. Designer drugs: Definition, Analogs of Fentanyl and Meperidine (both synthetic opioids), Phencyclidine (PCP), Amphetamines and methamphetamines (which have hallucinogenic and stimulant properties).

Unit 4:Laboratory Analysis (9 Hours)

The Chemist, Extractions: Physical Extraction, Dry Wash/Extraction, Liquid/Liquid Extractions, Analysis: Chemical Color Tests, Microscopic Techniques, Infrared Spectroscopy, Thin-Layer Chromatography, Ultraviolet Spectroscopy, Gas Chromatography. Format of NDPS Report Writing & Court Room Testimony.

Unit5: Drug Abuse in Sports (9 Hours)

Introduction, International Olympic Committee (IOC), World Anti-Doping Agency (WADA), classification of commonly prohibited substances and Performance enhancing Drugs, Steroids, Stack and Pyramid methods, Dope test and Blood Doping, Sampling techniques, analytical approaches.

Textbooks:

1. 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.
2. "Clarke's isolation and identification of drugs",edited by A. C. Moffatt., 2nd Edition, Pharmaceutical Press: London. 1986.
3. Modi,"Text Book of Medical Jurisprudence Forensic Medicines and Toxicology" CBS Pub. New Delhi, 1999
4. Saferstein. R, "Forensic Science Handbook", Volumes I, II and III, 2nd edition, Pearson, 2001
5. DFS -Working Procedure Manual- Narcotics
6. Stahl, E., "Thin-Layer Chromatography: A Laboratory Handbook", CBS Publishers and distributors, 2005
7. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		2	2		1		2	1	
CO2	1	1		2	2			1	2	
CO3	2		2	3		2	2		2	2
CO4	3	2	1	2			1	1	1	2
CO5	2	2			1	2	2	1	2	3
CO6	1	1	2	2	1	1	2	1		3

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3058	Advanced Pharmaceutical Toxicology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. know the chemical mediators and mechanisms by which the drugs act
2. know the drug therapy of certain disorders
3. understand different types of toxicities understand gene therapy

Course Outcomes:

The student will be able to

1. understand signaling molecules and receptors
2. summarize about signal transduction
3. understand the chemistry of mediators
4. understand about the pharmocotheraphy
5. summarize about reproductive toxicology
6. summarize about carcinogenity

Unit1: Molecular Mechanisms in Cell regulation (9 Hours)

Cell Regulation-.Signaling molecules and their receptors -Molecules: Nitric oxide, carbon monoxide, neurotransmitters, cytokines, peptide hormones, growth factors and eicosanoids - Receptors - Cell surface Receptors: Ion channels, G-protein coupled receptors, tyrosine kinase receptors, cytokine receptors, non-receptor protein tyrosine kinases - Nuclear receptors: Steroid hormone receptors, thyroxine receptors,

other nuclear receptor families - Signal transduction - Intracellular signal transduction: cAMP, cGMP, IP3-DAG, calcium pathway, PI3K/Akt, m-TOR, MAPK, JAK/STAT, TGFβ/Smad, NFB signaling, Hedgehog-Wnt, Notch pathways including Adrenergic and cholinergic transmissions. Other peripheral mediators: 5-HT and Purines, Cannabinoids, Peptides and proteins - Cytoskeleton signal transduction: Integrins and signal transduction, regulation of actin cytoskeleton

Unit 2: Chemical Mediators (9 Hours)

Biosynthesis, pathophysiological roles, receptors and drugs affecting the receptors for following - Mediators of inflammation and allergy: Histamine, Bradykinin, PAF, Eicosanoids: prostaglandins, thromboxanes, leukotrienes and related compounds, EDRF and vascular substances, oxygen free radicals, Cytokines, Cox- l and Cox-2.

Unit 3: Pharmacotherapy-1 (9 Hours)

Pathophysiology, Pharmacotherapy and critical analysis of rational use of drugs in the following disorders - Introduction to Pharmacotherapeutics - CVS: Hypertension, Ischaemic heart disease, CCF, Cardiac arrhythmias and dyslipidaemia. - Respiratory: Asthma and COPD -CNS: Parkinson's disease, Alzheimer's disease, Schizophrenia, Affective disorders, Epilepsy, insomnia, anxiety and pain management - Musculoskeletal: Rheumatoid & Osteoarthritis, hyperuricaemia, Myasthenia gravis.

Unit 4: Pharmacotherapy-II (9 Hours)

GIT: Peptic ulcer, GERD, Inflammatory bowel diseases, constipation, diarrhea - Endocrine: Obesity, Diabetes mellitus, Osteoporosis, Thyroid and parathyroid disorders - Infectious: UT infections, RT infections, GI infections (Bacterial and protozoal), Malaria, Tuberculosis, AIDS, Malignant: Leukaemia, Lymphomas and solid tumours.

Unit 5: Toxicity studies (9 Hours)

Acute, sub-acute and chronic studies: Protocols, objectives, methods of execution and regulatory requirements - Reproductive toxicology assessment: Male reproductive toxicity, spermatogenesis, risk assessment in male reproductive toxicity, female reproductive toxicology, oocyte toxicity, alterations in reproductive endocrinology, relationship between maternal and developmental toxicity - Mutagenicity: In vitro tests for gene mutations in bacteria, chromosome damage, gene mutations in vivo (micronucleus tests and metaphase analysis) in rodents - Carcinogenicity studies: In vivo and In vitro studies - Toxicological requirements for biological and bio-tech products: Safety analysis, concept of safety Pharmacology, antibodies, transmission of viral infections, residual DNA

Text Books:

1. Brunton, L.L, Hilal-Dandan, R and Knollmann, B.C., "Goodman and Gilman's The Pharmacological Basis of Therapeutics" 13th Edition. McGraw Hill, New York, 2018.
2. Rang, H.P, Dale, M,M., and Ritter, J,M, "Pharmacology", 6th Edition, Churchill Livingstone, London, 1999.
3. Katzung, B. G, "Basic and Clinical Pharmacology",8th Edition, Lange Medical Book/McGraw-Hill, U.S.A., 2001)
4. D.R. Laurence, D. R, Bennett, P. Nand Brown, M., "Clinical Pharmacy" 8th Edition, Churchill Livingstone, 1997.
5. Herfindal,E. T and Hirschman, "Clinical pharmacy and therapeutics" 3rd edition, Williamsand Wilkins Publications 1984
6. Walker, R and Whittlesea, C, "Clinical pharmacy and therapeutics",5th Edition, Churchill Livingstone Publication, 2012
7. Waynforth, H.B, and Flecknell, P, "Experimental and Surgical Techniques in the Rat", 2nd Edition, Academic Press, 1992.

Reference Books:

1. Jameson, J. L, Fauci, A. S, (Author), Kasper, D. L, Hauser, S. L, Longo, D. L and Loscalzo. J, "Harrison's Principles of Internal Medicine" 20th Edition, Volume I & Volume II, McGraw Hill Education, 2018 Pharmacotherapy; A pathopysiologic approach-Joseph T.Dipiro et.al Appleton and Lange
2. Ballantyne, B., Marrs, T and Syversen, T (eds). "General and Applied Toxicology", 2nd Edition, 3 Vols, Macmillan Press, 2000

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		1	2	2	1		2	1	

CO2	1	2		2		2	1	1	2	
CO3	3	2	1	2		1	1	1	1	
CO4	2		1	3	1	2	1	1	2	3
CO5	3	2	2	1	2		1	2	1	3
CO6	1	3	2		2		2	2	2	2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3059	Analytical Forensic Toxicology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the basic steps involved in sample collection
2. Learn the methods involved in analysis of alcohol intoxification
3. Summarize various types of poisons

Course Outcomes:

The student will be able to

1. Apply the methods of sample collection
2. Understand the steps involved in alcohol intoxification
3. Summarize the types of animal poisons
4. Summarize the types of plant poisons
5. Summarize the types of gaseous poisons
6. Summarize the types of food poisons

Unit 1: Samples required in Toxicological analysis (9 Hours)

Selection of Post-mortem samples and reference to particular class of poison, Classes of samples (Biological and Non-biological), Methods of sample collection (Living and Dead person), Classification of matrices, choice of preservatives, containers and storage conditions. Alternative specimens: Hair analysis, Drugs in oral fluid, Detection of drugs in sweat etc. Analysis of Exhumed and decomposed bodies.

Unit 2: Alcohol Intoxication & analysis (9 Hours)

Related cases, Properties and types of Alcohols, Pharmacology, Toxic properties and effects of alcohol. Chemical tests for alcohol in blood and urine including Breath Alcohol Screening devices, Method of analysis of some alcoholic beverages in biological materials by chemical methods (Kozelka- Hine) and instrumental methods (GC), Legal context to drinking and driving. Format of Report Writing & Court Room Testimony: Information required by the Forensic toxicologist, Presenting findings in a Report format.

Unit 3: Animal and Plant Poisons (9 Hours)

Insects and animal toxins and their examination, Composition of Snake venoms, Sites and mode of action, Effect on the body as a whole, and tests for identifications. Plant poisons: Classification and characteristics, method of extraction and stripping of plant poisons in matrices and analysis by chemical and instrumental techniques.

Unit 4: Gaseous Poisoning (9 Hours)

Carbon Monoxide, Hydrogen Cyanide and Phosphine gase, significance, signs and symptoms, methods of diagnosis, tests for identification.

Unit5:Food Poisoning (9 Hours)

What is food poisoning, Food poisoning due to chemical and bacterial, 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.

Suggested books:

1. Moffat, A. C,Osselton, M. D, Widdop, B and Watts, J, "Clarke's Analysis of Drugs and Poisons" Fourth edition, Pharmaceutical Press: London. 2011,
2. Curtis D. Klaassen, "Casarett&Doull's Toxicology: The Basic Science of Poisons" 9th edition, McGraw-Hill Education, 2019
3. Curry A.S, "Analytical Methods in Human Toxicology, Part II" CRC Press, Ohio,1986.

4. Curry A. S., "Poison detection in human organs (American lecture series)", Thomas Publishers, 1976.
5. CRC Handbook of Toxicology, Edited by M. J. Derelanko and M. A. Hollinger, CRC Press, 1995.
6. Morgan B.J.T, “Statistics in Toxicology” Clarendon Press, Oxford.1996
7. Modi,”Text Book of Medical Jurisprudence Forensic Medicines and Toxicology” CBS Pub. New Delhi, 1999
8. Saferstein. R, "Forensic Science Handbook", Volumes I, II and III, 2nd edition, Pearson, 2001
9. DFS Manual of Forensic Toxicology

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1		2	2	1		1	1	
CO2	1		2	2	1	1	1	1	1	
CO3	2	3	1	2		2	1	2	1	
CO4	2	1	2		2	1	2	1	2	3
CO5	2	3	1	2		2	2	2	2	2
CO6	3	2	2		1	1	2		2	2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-‘ No correlation

20CH3060	Electrochemical Devices for Electric Vehicles	L	T	P	C
		3	**0**	**0**	**3**

Course Objectives:

Enable the student to

1. learn the basics of electrochemical devices
2. learn the fundamentals of energy storage and testing procedures
3. learn about the future of electric vehicles

Course Outcomes:

The student will be able to

1. understand the fundamental concepts of electrochemical devices
2. understand the principle, design and application of storage batteries
3. understand the evaluating procedures of electrochemical devices
4. know the principles of electrochemical capacitors
5. know concepts of operation of fuel cell systems
6. understand about basics of hybrid electric vehicle

Unit 1: Basics of electrochemical devices (9 hours)

EMF, reversible and irreversible cells, free energy, effect of cell temperature, thermodynamic calculation of the capacity of a battery, calculations of energy density of cells - Factors affecting battery capacity, voltage level, current drain of discharge, types of discharge: continuous, intermittent, constant current, constant load, constant power, service life, voltage regulation, charging methods, battery age & storage condition.

Unit 2: Storage batteries (9 Hours)

Principle, design, construction, performance characteristics, advantage and disadvantages - Primary batteries - Zn-MnO_2 carbon-zinc, carbon-zinc chlorides, and zinc-silver oxide- Secondary batteries – lead-acid, nickel-cadmium, nickel-metal hydride, silver oxide-zincsystem, lithium-ion, lithium- polymer battery systems - Battery maintenance and safety precautions - Application of phase-change materials for energy conservation - Batteries for electric vehicle applications.

Unit 3:Testing& evaluation of electrochemical devices (9 Hours)

Evaluation of active mass, surface area measurement - BET method - Internal resistance ofcells - A.C. impedance method - Testing of capacity, retention of charge, vibration,life, efficiency, leakage for sealed cells, high rate discharge, testing of separators.

Unit 4: Fuel cells & super capacitors (9 Hours)

Introduction to super capacitors, types of super capacitors - Introduction to fuel cells, types offuel cells and technology development - Polymer electrolyte, direct methanol, phosphoric acid, molten carbonate and solid oxide fuel cells – Material related challenges - Stack engineering - Microbial fuel cells

Unit 5: Future of Electric vehicles (9 Hours)

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles - Laboratory Test of Electric Vehicle Batteries, Vehicle tests with Electric Vehicle Batteries, Safety of electric vehicle, Charging station and Fast Charging of Li-ion battery - Future of Electric Vehicles.

Text Books:

1. Linden, D., Reddy, T.B., "Hand book of batteries and Fuels", 3rd Edition, McGraw Hill Book Company, 2002.
2. McNiol B.D., Rand, D.A.J, "Power Sources for Electric Vehicles", Elsevier Publications, 1998.
3. Nazri, G.A., "Lithium batteries – Science and Technology", Springer, New York, 2009.
4. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems", Boca Raton,CRC Press, 2003.
5. Husain, I., "Electric and Hybrid Vehicles", Boca Raton, CRC Press, 2010.

Reference Books:

1. Pavlov, D., "Lead – Acid Batteries: Science and Technology", Elsevier, Amsterdam, 2011.
2. Conway B. E., "Electrochemical Supercapacitors: Scientific Fundamentals andTechnological Applications", Kluwer Academic / Plenum publishers, New York, 1999.
3. Mench, M., "Fuel Cell Engines", John Wiley, New York, 2008.
4. Viswanathan, B., Scibioh, Aulice, M., "Fuel Cells, Principles and Applications", Universities Press, 2006.
5. Williamson,S.S., "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2						3	2	2
CO2		3		3	3			3	2	3
CO3					3				2	
CO4	3	3						3	2	2
CO5		3							2	
CO6			3			3		3	3	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3061	Entrepreneurship and Business Plan	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. Understand about various standards used
2. know about the laboratory management and quality management
3. understand the basics of Entrepreneurship skills

Course Outcomes:

The student will be able to

1. summarize various chemical standards
2. Summarize various biological standards
3. Understand about the quality management systems
4. Realize the importance of various accreditation
5. understand the basics of entrepreneurship
6. apply the steps used for project management

Unit 1: Standards for analysis (6 Hours)

Basic standards – Need of standards is analytical sciences – Basic chemical standards – Analytical standards – Reference materials – High purity substances – Certified reference materials – Working or secondary standards – Matrix effect in standards – Biological standards – Biochemical standards – Microbial cell lines and standards

Unit 2: Quality Management-I (6 Hours)

Introduction – Quality - Quality system – Quality plan – Inspection and testing – Test records – Control of inspection - Handling, storage, packaging, preservation and delivery of the material – Control of quality records – Internal quality audits – Quality assurance –

Unit 3: Quality Management – II (6 Hours)

Training Laboratory Accreditation – ISO 9000 - ISO 14000 and 17000 series of standards – Accreditation Boards – NABL guidelines for accreditation in India Proficiency testing system – Internal quality control – Inter and intra laboratory testing programmes – Designing and running the proficiency testing programmes – Confidentiality - Advantages of accreditation

Unit 4: Basics of Entrepreneurship (6 Hours)

Concept – Definition – Structure – Theories of entrepreneurship – Types of Start-ups – Types of entrepreneurs – Environment – The process of entrepreneurial development – entrepreneurial culture – Entrepreneurial leadership – Product planning and development – project Management – Search for business idea

Unit 5: Concepts of Projects (6 Hours)

Concept of projects – project identification – Formulation – Design and network analysis – Project report and project appraisal - Basis and challenges of entrepreneurship – Innovation and Enterpreneurship in technology based organizations – Technology absorption – Networking with industries and institutions

Textbooks

1. 1.Woodget, B. W. and Cooper, D., "Sample and Standards", ACOL Series, Wiley, 1987
2. Dux, J. P., "Hand Book of Quality Assurance for Analytical Chemistry Laboratory", Van Nostrand, 1986
3. Duncan, W. L and International, L.W, "Total Quality: Key Terms and Concepts" AMACOM publishers, 1995
4. Shah, D. H., "QA Manual", Business Horizons, 2000
5. Kumar, K., "Quality Management", ABD Pub., 2000
6. Gyani, G. J. "Training Manual on ISO 9000; 2000 and TQM", Raj Pub., 1999
7. Desai, V., "Dynamics of Entrepreneurial development and Management", Himalaya Oublishing House, 2011
8. Rao, T. K and Naidu, N.V.R,."Management and Entrepreneurship", Dreamtech Press, 2019
9. Rao T. V and Kuratko, D. F, "Entrepreneurship A South-Asian Perspective", Cengage, 2012

20FS3001	Forensic Science and Criminal Justice System	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about the fundamental principles and functions of forensic science
2. understand the significance of forensic science to human society
3. know the working of the forensic establishments in india

Course Outcomes:

The student will be able to

1. understand the importance of forensic sciences
2. summarize the organizations in India related to forensic science
3. understand the importance of collecting physical evidence
4. know the problems in society and collecting the evidences
5. understand the importance of criminal justice system
6. describe the recent advancements in Forensic science

Unit 1: Introduction to Forensic Science (9 Hours)

Forensic Science – Introduction – History - - The Role of the Forensic Laboratory, History and Development of Forensic Science in India & Abroad, Pioneers in Forensic Science, Multidisciplinary nature, Forensic Technology solving crimes with advanced technology, Forensic intelligence and Interviews. Administration and Organizational Setup: DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB, NICFS, CDTS, NCRB, BPR&D, Qualifications and duties of Forensic Scientists Academic centres of education and research: Indian and Academy of Forensic Science, American Board of Forensic

Odontology, Interpol and FBI, Australian Academy of Forensic Sciences -Duties of Forensic Scientists –

Unit 2: Physical Evidence (9 Hours)

Physical evidence and Locard's exchange principle – Classification of physical evidence - Role of Forensic Science in crime investigation - Crime scene – Types - Processing of crime Scene - Chain of custody - Probative value of physical evidence - Reconstruction of scene of crime - Investigation of crime - Modus operandi – Court Testimony – Introduction - Admissibility of expert testimony - Expert and lay witnesses – Giving testimony as an Expert

Unit 3: Sociology (9 Hours)

Sociology – Introduction – Society - Culture and socialization – Social problems in India – Social change – Sociological causes of crime – Relation of sociology to other sciences Criminology – Introduction – cope of Criminology – Concept and definition of crime – Criminal behaviour - Types of crimes – Schools of Criminology – Causes of crime – Juvenile delinquency - Criminal profiling Penology – Theories of punishment – Types of punishments – Capital punishment – Prisons and correctional institutions – Objectives – Administration – Functioning and limitations

Unit 4: Criminal Justice System (9 Hours)

Criminal Justice system in India – Introduction – Administration of civil and criminal justice – Hierarchyof courts – Powers of courts – Types of courts – Lok Ayukta system The structure of Police organizations in India – Functions and duties of police – Investigation of crimes and prosecution – Cognizable and Non- cognizable offences - Powers of police to search, seize and arrest – Role and responsibilities of prosecution – Third degree methods - Human rights – Scientific methods of investigation Introduction to constitution of India – Indian penal Code - Introduction – Sections 171B, 171E, 291, 292,293, 299, 300, 302, 304B, 308, 309, 362, 375, 376, 390, 391, 415, 420, 463, 465 - Criminal ProcedureCode Introduction – Sections 291, 292, 293, 300 – Indian Evidence Act - Introduction – Sections 45, 46,47, 57, 58, 60, 73, 135, 136, 137 and 159

Unit 5: Recent Trends in Forensic Science (9 Hours)

Recent Trends in Forensic Science- Environmental Forensics: Definition, Legal processes involving environmental forensic science. Geo-forensics Global Positioning System; Basic principles and applications. Biometrics in Personal Identification: Introduction, Concepts of Biometric Authentication, Role in person Identification, Techniques and Technologies (Finger Print Technology, Face Recognition,IRIS, Retina Geometry, Hand Geometry, Speaker Recognition, Signature Verification and other forensicrelated techniques). Bioterrorism: Definition, Concepts of Biosecurity and microbial forensics, Weapons of mass destruction (WMD), mass-casualty weapons (MCW), NBC and CBRNE, Dirty Bombs.

Textbooks:

1. James, S. H., Nordby, J. J. and Bell, S., "Forensic Science: An Introduction to Scientific and Investigative Techniques", 4th Edition, CRC Press, USA, 2015.
2. Saferstein, R., "Criminalistics: An Introduction to Forensic Science", 11th Edition, Pearson, 2015.
3. Siegel, J. A, Saukko, P. J., Knupfer, G. C., "Encyclopedia of Forensic Sciences, Vol I, II and III", Academic Press, 2000.
4. Horswell, J., "The Practice of Crime Scene Investigation (International Forensic Science and Investigation)" 1st Edition, CRC Press, 2004.
5. Sharma, B.R., "Forensic Science in Criminal Investigation & Trials", Universal Law Publishing – An imprint of LexisNexis, 5th Edition, 2014.
6. Rao C.N. Shankar, "Sociology: Principles of Sociology with an Introduction to Social Thoughts" S Chand, 6th Edition, 2006 (2019).
7. Bhushan, V., Sachdeva, D.R., "An Introduction to Sociology", Kitab Mahal, 16th Edition, 1986.
8. Shapiro, D.L., "Forensic Psychological Assessment: An Integrative Approach", Allyn & Bacon, 1990.
9. Turvey, B., "Criminal Profiling – An introduction to behavioral evidence analysis', 4th Edition, Academic Press, 2011.
10. Lal, R., Lal, D., "The *Indian Penal Code", 28th Edition, Wadhwa*&*Co., 2002.*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3							3	2	2
CO2							3			
CO3		3								
CO4		3					3			
CO5							3			
CO6								3	2	2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3002	Forensic Physics and Advanced Ballistics	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. understand the physics of Blood and various materials
2. describe the causes and investigation of vehicular accidents, and its legal implications.
3. understand about firearms and their classification

Course Outcomes

The students will be able to:

1. understand the examination of road accident
2. understand the physics of blood
3. analyze various types of material
4. classify the various types of fire arms
5. distinguish between, internal, external and terminal ballistics
6. summarize the procedure of writing ballistic report

Unit 1: Introduction to Forensic Physics (7 Hours)

Nature, collection, preservation & forwarding of physical evidencefor scientific examinations. Forensic Engineering; Fire investigation; Industrial accidents; Traffic accident reconstruction; Transportation disaster investigation; Civil engineering investigation; Investigation report. Road Accidents- Examination of scene, Filaments examination, Examination of skid marks,

Unit 2: Physics of Blood (7 Hours)

Physics of Blood stain Pattern Analysis (BPA): Introduction, Terminologies and classification, Biological and physical properties of human blood, Droplet Directionality from bloodstain patterns, Determination of Point of Convergence and Point of Origin. Impact spatter and mechanisms. Importance and Legal aspects of BPA.

Unit 3: Glass, Soil and Paint (11 Hours)

Glass -Types of glass and their composition, Glass fracture analysis, Laboratory exercises include refractive index measurements using immersion methods and classical chemical and physical methods of analysis. Soil- Formation and types of soil, Composition and color of soil, Forensic examination of soil, Interpretation of soil evidence. Paints- Types of paint and their composition, Forensic examination of paints, Interpretation of paint evidence. Tool Marks- Types of tool marks, Class characteristics and individual characteristics - Fiber analysis: Forensic significance, Classification, characteristics, Birefringence, Colors in textile, Color Assessment, Chemical properties, Miscellaneous Clue Materials- Examination of strings/ropes, Wires/cables, Seals, Counterfeit coins, Gem Stones: Analysis of crystalline substances. Building Materials- Types of cement and their composition, Determination of adulterants, Analysis of cement mortar and cement concrete and stones. Forensic examination of electrical appliances/installations

Unit 4: Fire Arms and Internal Ballistics (11 Hours)

Firearms: Definition, Breech Loader and Muzzle loader, Smooth bore and Rifled firearms, Briefs of Indian Arms Act, Country Made/Improvised Firearms, Illegal firearms - Proof Marks of weapons - Types of ammunition- types of cartridges, types of primers and priming composition, propellants and their compositions, velocity and pressure characteristics under different conditions, various types of bullet and compositional aspects, latest trends in their manufacturing and design projectile, Head stamp Markings. Internal Ballistics: Definition, Ignition of the propellant, Shapes of Propellants, Manner of the propellant burning, Piobert's law, Pressure space curve, Shot Start Pressure, All Burnt Point, Velocity, Le Du's

formula, Muzzle velocity - factors affecting the internal ballistics - equation of motion of projectile, Measurement of strength of firearm, projectile velocity determination, theory of recoil, methods for measurement of recoil.

Unit 5: External Ballistics and Terminal Ballistics (9 Hours)

External Ballistics: Bullet Drop in the flight, Use of sight to compensate for bullet drop, Influence of Earth on Trajectory, Angle of Fall, Ballistic Coefficient and Air resistance-base drag, Sectional Density, Maximum effective range, Drift, Yaw ,Precession, Nutation, Terminal velocity, Ballistics tables, measurements of trajectory parameters, Escape velocity & Ricochet.Terminal Ballistics: Definition, Effect of projectile on hitting the target: function of Bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, function of bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, Brief introduction to Cavitations -Ricochet and its effects, stopping power - Introduction to Forensic Ballistics Report Writing

Textbooks:

1. Hatcher J.S., Jury, F.J., Weller, J., "Firearms Investigation Identification and Evidence", Ray Riling Arms Books Co. Philadelphia, PA; Reprint edition (October 4, 2006)
2. Jauhri, M., "Monograph on Forensic Ballistics", Govt. of India Publication, New Delhi, 1980.
3. Sharma, B.R., "Forensic Science in Criminal Investigation & Trials", Universal Law Publishing – An imprint of LexisNexis, 5th Edition, 2014.
4. Kumar, K., "Forensic Ballistics in Criminal Justice", Eastern Book Company, Edition: 1987 Edition W/S 1990, Reprinted 2015.
5. Heard, B.J., "Handbook of Firearm and Ballistics Examination and Interpretation Forensic Evidence", Wiley, 2008.
6. Warlow, T., Warlow, T.A., "Firearms, the law and Forensic Ballistics", CRC Press, 1996.
7. Jacobson, R., Ray, S., Attridge, G.G., Axford, N., "Manual of Photography", Ninth Edition (Media Manual), 9th Edition, Focal Press, 2000.
8. Saferstein, R., 'Forensic Science Handbook Volume 1", Pearson, 2nd Edition, 2001.
9. James S.H., Nordby, J.J., "*Forensic Science*: An *introduction* to *scientific* and *investigative techniques", CRC Press, USA, 2003.*
10. *Working Procedure Manual* - Toxicology, *BPR&D Publication, 2000*.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1				3				3	2	2
CO2					2			2		
CO3					3			3		
CO4		3						3		
CO5					2					
CO6					2			2		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3003	Forensic Biology	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. understand the basics of forensic biology
2. know the details of body fluids, stains and tissues
3. Understand about forensic anthropology, examination of hair and wildlife forensics

Course Outcomes

The students will be able to:

1. understand the various forms of biological evidences
2. know the chemistry of blood and semen
3. become a forensic anthropologist
4. to perform hair analysis
5. know the importance of wildlife

6. identify bacteria and viruses

Unit 1: Introduction to Forensic Biology (8 Hours)

Introduction – Scope - Various forms of biological evidences like wood, timber varieties, seeds and leaves - Their identification and matching Forensic Botany - Toxic principles of plants and their forensic significance - Identification of poisonous plants and mushrooms of India -Diatoms - Types – Morphology - Methods of isolation from tissues and bones - Forensic significance in drowning cases - Study and identification of pollen grains - Identification of starch grains, powder, stains of spices - Paper pulp identification - Isolation and identification of microbial organisms

Unit 2: Body Fluids, Stains and Tissues (8 Hours)

Blood - Compositon, histology, examination of blood and blood stains, Identification of lochial and menstrual stains by various methods. Semen - Composition, St. of spermatozoa, Forensic methods of detection and identification of semen and seminal stain examination - Identification and examination of other body fluids/stains- vaginal, saliva, urine, pus, faeces, vomit, milk, sweat & tears.

Unit 3: Forensic Anthropology (9 Hours)

History - Scope and development - Role of forensic anthropologist – Collection and preservation of evidences - Human osteology - Determination of age, sex, stature- Determination of personal identity by superimposition technique - Video image analysis - Facial reconstruction – Legal provisions and tools involved in it - Pathology of bones and its importance in identification - Identification of burnt bones, skeletal remains in accidents, crimes and mass disaster Forensic Odontology: Introduction - Structure and types of teeth - Dentition and dental formula – Dental diseases - Determination of age, sex and race from teeth - Role of teeth in mass disaster – Forensic significance in identification

Unit 4: Examination of Hair (10 Hours)

Introduction - Structure of hair - Growth and chemistry of hair - Identification and comparison of hair by microscopic – Chemical - Biochemical and instrumental methods - Identification of animal hair - Assessment of age, sex, race and site of hair - Analysis of drugs and elements in hair – Hair diseases - Hair transfer, persistence and recovery - DNA typing of hair Fibre Examination – Introduction - Classification of fibres - Identification and comparison of fibres by physical - Chemical – Microscopic – Spectroscopic - Chromatographic methods - Persistence and recovery of fibres - Forensic significance Forensic Entomology: Introduction - Analyzing crime scene for entomological evidence - Collection of climatological data and specimen before body removal - Common arthropod found on the dead body - Determination of time of death - Entomological succession in case of buried, drowned and buried bodies

Unit 5: Wild life Forensics and Forensic Microbiology (10 Hours)

Wild Life Forensics: Introduction - Importance of wild life - Wild life Protection Act – Endangered species – CITES - Census of wildlife population - Wild life crime - Methods of smuggling and poachingof wild life artifacts - Crime scene search - Criminal investigation - Determination of time of death – Sexdetermination from bones - Identification of teeth, claws, Ivory, Horns, antlers, furs, skin, bite marks, pugmarks - Identification of blood, excreta and bones by biochemical and immunological methods- Forensic Microbiology: Definition, Types and identification of Bacteria and Viruses in Forensic Science, Microbial profiles as identification tools, use of microorganisms in bioterrorism, Anthrax, transmission of HIV as a criminal act, role of microbes in food poisoning

Textbooks:

1. Robertson, J., "Forensic Examination of Fibres", Chichester, West Sussex, England: Ellis Horwood Ltd., 1992.
2. Saferstein, R., "Criminalistics. An Introduction to Forensic Science", 11th Edition., Pearson, 2015.
3. Robertson, J.R., "Forensic Examination of Hair", 1st Edition, CRC Press, 1999.
4. Eckert, W.G., "Introduction to Forensic Sciences", 2nd Edition, CRC Press, 1996.
5. Kirk, P. L., "Crime Investigation", Interscience, New York, *1953*.
6. Jams, S.H., Nordby J.J., Bell, S., "Forensic Science: An Introduction to Scientific and Investigative Techniques", 4th Edition, CRC Press, 2015.
7. Wild Life (Protection) Act, 1972, Universal Law Publishing - An imprint of LexisNexis, 2016.
8. Pillay, V.V., Textbook of Forensic Medicine & Toxicology, 18th Edition, Paras Medical Publisher, 2017.
9. Byrd, J. H., "Forensic Entomology: The Utility of Arthropods in Legal Investigations", 2002.

10. Chowdhuri, S. "Forensic Biology", B P R & D, Govt. of India, 1971.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3			2			3	2	1
CO2				3						
CO3					3					
CO4					3					
CO5							2			
CO6					3					

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3004	Advanced Questioned Documents	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn examining the questioned documents using various detection apparatus
2. identify the forgery by comparing documents
3. learn to identify the forgery

Course Outcomes:

The student will be able to

1. understand the various types of documents
2. compare the questioned documents with standards
3. identify the different types of forgery in the documents
4. apply various method to analyze questioned documents
5. analyze the questioned documents of various types
6. prepare the report

Unit 1: Classification of Documents (9 Hours)

Nature and problems of document examination – Classification of documents – Procurement of standard admitted / specimen writings –Handling and marking of documents – Preliminary examination of documents- Basics of handwriting identification – Individuality of handwriting – natural variations, process of comparison – Various types of documents – Various writing features and their estimation – General characteristics of hand writing – Individual characteristics of hand writing – Basic tools for forensic document examination

Unit 2: Examination of Signatures (9 Hours)

Disguised writing and anonymous letters – Identification of writer – Examination of signatures – Characteristics of genuine and forged signatures – Examination of alterations, erasers, over writings, additions and obliterations – Decipherment of secret, indented and charred documents – Examination of seal impressions and other mechanical impressions

Unit 3: Examination of Documents (9 Hours)

Examination of black and white, colour Xeroxed copies, carbon copies, fax messages – Forgeries and their detection – Various types of forgeries and their detection – Examination of built up documents – Determination of sequence of strokes, physical matching of documents, identification of typewriter writings – Identification of typewriter – Identification of printed matter – Various types of printing of security documents , printing of currency notes – Examination of counterfeit currency notes, passports, visa, stamp papers, postal stamps etc.

Unit 4: Analysis of Documents (9 Hours)

Determination of age of documents by examination of signatures, paper, ink, writing / signatures etc.- Examination of computer print outs – dot-matrix, ink-jet and laser printers, electronic typewriters – creditcards – e-documents – Digital signatures – Opinion writing – Reasons for opinion – Court testimony Analytical instrumentation used in document examination – Video spectral comparators, Microscopes,TLC, HPLC, Spectrofluorimetry and X-ray fluorimetry etc.

Unit 5: Report Writing & Court Room Testimony (9 Hours)

Evidence and testimony in court, Information required by the Forensic expert, Components of Forensic Reports, Preparation of Report, Presenting findings in a Report format.

Textbooks:

1. Morris, R., Morris, R.N., Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, 2000.
2. Huber, R.A., Headrick, A.M., Handwriting Identification: Facts and Fundamentals, CRC Press, 1999.
3. Osborn, A. S., "The Problem of Proof", 2nd Edition, Universal Law Publishers, 1998
4. Thomas,C.C., "I.S.Q.D. Identification System for Questioned Documents", Billy Prior Bates, Springfield, Illinois, USA, 1971.
5. Harrison, W.R., "Suspect Documents: Their Scientific Examination", Universal Law Publisher, 1997.
6. Levinson, J., "Questioned Documents: A Lawyer's Handbook", 1st Edition, Academic Press, 2000.
7. Saferstein, R., "Criminalistics: An Introduction to Forensic Science", Prentice-Hall; 5th Revised Edition, 1994.
8. Day, S. P., Ellen, D., Davies, C., "The Scientific Examination of Documents: Methods and Techniques (Taylor & Francis Forensic Science Series), Taylor & Francis; 2nd Edition, 1997.
9. Morris, R. N., "The Identification of Handwriting & Cross Examination of Expert, NM Tripathi, Allahabad, 1970.
10. Saxena, B.L., "Law and Technique Relating to Identification of Handwriting, Disputed Documents, Finger Prints, Foot Prints, and Detection of Forgeries", Central Law Agency, Allahabad, 1968.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1					2			3		
CO2						6				
CO3							2	3	2	1
CO4					3					
CO5					2					
CO6							2			

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

0FS3005	Finger Prints and other Impressions	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn examining the various types of finger prints
2. identify the footwear and tire inpressions
3. learn to identify the lip print

Course Outcomes:

The student will be able to

1. understand the various elements of fingerprints
2. understand the types of reprints
3. Analyze footwear reprints
4. Apply various methods to analyze tire reprints
5. Analyze the Lip reprints
6. Analyze the bite marks

Unit 1: Introduction to Fingerprints (9 Hours)

Fingerprints- Introduction- History and development of fingerprints- Structure of skin- Elements of fingerprinting - Classification of fingerprint patterns- Classification of fingerprints- Identification and comparison- Poroscopy- AFIS- Introduction- History- Operation- Search technology- Palm prints – Administration and networking.

Unit 2: Types of Fingerprints (9 Hours)

Types of evidentiary fingerprints- Development of latent fingerprints- Physical and chemical methods- Visualization methods of illumination- Photography- Preservation and lifting of fingerprints- Development techniques on porous and non-porous surfaces- Development on adhesive surface-

Development with blood and grease contamination-Development of latent fingerprints on dead body-Digital imaging of fingerprints- Case histories.

Unit 3: Footwear Fingerprints (9 Hours)

Footwear Impressions- Introduction- Forms of footwear impressions- Information from footwear impressions- Location and recovery of footwear impressions- Enhancement methods- Preparation of Exemplars- The examination process- Case histories

Unit 4: Tire impressions (9 Hours)

Introduction- Original equipment tires, Replacement tires and tire construction- Tread nomenclature and sidewall information- Tread wear indicators- Retreated tires- Tire reference material and databases- Tire track evidence and recovery- Known tires and exemplars- Tire impressions
examination process- Case histories

Unit 5: Lip Prints (9 Hours)

Lip Prints- Introduction- History- Scope- Application in crime detection Ear Prints- Introduction- History- Morphology of ear – Ear prints location- Producing standards from suspects- Identification and comparison Bite marks- Introduction- Significance- Judicial Acceptance- Description of prototypical bite marks- Evidence collection on victim and suspects- Identification and comparison- Case histories.

Textbook:

1. Ashbaugh, D.R., "Quantitative-Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced Ridgeology (Practical Aspects of Criminal and Forensic Investigations)", CRC Press, 1st Edition, 1999.
2. Mehta, M.K., "The Identification Of Thumb Impressions and The Cross Examination of Finger Print Experts", 2nd Edition, N.M. Tripathi Publishers, Bombay, 1963.
3. Lee, H.C., Ramotowski, R., Gaensslen, R.E., "Advances in Fingerprint Technology, Second Edition (Forensic and Police Science Series)", CRC Press, 2001.
4. Saferstein, R., "Criminalistics: An Introduction to Forensic Science", Pearson Prentice Hall, 11th Edition, 2014.
5. Eckert, W.G., "Introduction to Forensic Sciences", 2nd Edition, CRC Press, 1996.
6. James, S.H., Nordby, J.J., Bell, S., "Forensic Science: An Introduction to Scientific and Investigative Techniques", 4th Edition, CRC Press, 2015.
7. *Siegel, J. A., Sukoo, R. J, Knupfer, G. C., "Encyclopedia* of *Forensic Science, Vol* I, *II* and *III, Academic Press, 2000.*
8. *Kirk, P.L., "Crime Investigation: Physical Evidence and the Police Laboratory", Interscience, New York, London, 1953.*
9. O'Hara, C.E., Osterburg, J.W., Introduction to Criminalistics, The Macmillan Company, 1949.
10. O'Hara, C.E., "An Introduction to Criminalistics;: The Application of the Physical Sciences to the Detection of Crime", Indiana University Press, 1972.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3						3	2	1
CO2					3			3		
CO3					3				2	1
CO4					3			2		
CO5					3				3	
CO6					3					1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3006	Crime Scene Management Lab	L 0	T 0	P 3	C 2

Course Objectives:

Enable the student to

1. learn sketching the crime scene
2. collect the physical evidences from the crime scene
3. learn to reconstruct and evaluate the crimescene

Course Outcomes:

The student will be able to

1. understand the methods of sketching the outdoor crime scene

2. understand the methods of sketching the indoor crime scene
3. collect the evidences from the crime place
4. understand the methods of packing the physical evidence
5. summarize the evaluation of indoor crime scene
6. summarize the evaluation of outdoor crime scene

List of Experiments:

1. Sketching the scene or a crime
2. Sketching of Outdoor crime scene (murder, suicide, accident etc)
3. Sketching of Indoor crime scene (theft, dacoity, murder, suicide etc)
4. Photography of crime scene using manual & digital camera.
5. Collection and packing of physical evidence at the scene of crime
6. Searching of physical evidences at scene of crime.
7. Collection, packing, labeling and forwarding of physical evidence from scene
8. Reconstruction and evaluation of indoor crime scene
9. Reconstruction and evaluation of outdoor crime scene
10. Physical evidence and Locard's principle
11. Polygraphy (Demonstration only)
    (Minimum10 experiments to be completed)

Textbook:

1. Miller, M.T., "Crime Scene Investigation Laboratory Manual", Academic Press, 1st Edition, 2013.
2. Sutton, R., Trueman, K., "Crime Scene Management: Scene Specific Methods", Wiley, 2016.
3. Crime Scene Investigation, A Guide for law Enforcement, Research Report, US Department of Justice, 2000.
4. Dutelle, A.W., "An Introduction to Crime Scene Investigation", Jones and Bartlett Publishers, LLC, 2011.
5. Mozayani, A., Noziglia, C., "The Forensic Laboratory Handbook Procedures and Practice", Springer, 2011.
6. Jones, P., Williams, R.E., "Crime Scene Processing and Laboratory Workbook", CRC Press, Taylor & Francis Group, 2009.
7. Krishnamurthy, R., "Introduction to Forensic Science in Criminal Investigation", Selective& Scientific Books, 2015.
8. Houck, M.M., Crispino, F., McAdam, T., "The Science of Crime Sciences", Academic Press, 2012.
9. Saferstein, R., "Forensic Science: From the Crime Scene to the Crime Lab", 4th Edition, Pearson, 2019.
10. Mozayani, A., Noziglia, C., "The Forensic Laboratory Handbook Procedures and Practice", Springer, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1			3							
CO2			3		3			3	2	1
CO3										
CO4				3						
CO5						3		3	2	1
CO6						6			2	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3007	Forensic Physics and Ballistics Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand the analysis of soil, paint and glass samples
2. know about tool marks
3. understand about microscopic examination of different samples

Course Outcomes:

The student will be able to

1. examine paint sample
2. analyze the soil
3. examine the bullet
4. do density gradient method
5. experiment paint samples
6. know about the methodology to collect digital evidences

LIST OF EXPERIMENTS

1. Examination of glass fractures
2. Determination of refractive indices of glass & liquids
3. Physical examination of soil for colour, moisture, organic matter, pH, presence of anthropogenic
4. material and presence of biological material
5. Determination of particle size distribution of soils
6. Soil comparison by density gradient method
7. Examination of paint samples by microscopy
8. TLC and spectrophotometric comparison of paint evidence
9. Examination of counterfeit currency
10. Comparison of tool marks
11. Restoration of erased identification marks from metal surfaces
12. Determination of density, by density gradient tube techniques.
13. Comparison of paints, Soils and glass.
14. Miscellaneous (Cloth and Bangles)
15. Bloodstain pattern analysis
16. Preparation of report of the examination.

(Minimum10 experiments to be completed)

Textbook:

1. Robinson, J.W., "Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York, 1995.
2. Redsicker, D.R., "The practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton, 2000.
3. Mirakovits, K., Londino, G., "The Basics of Investigating Forensic Science", CRC Press, 2015.
4. Franck. H., Franck, D., "Forensic Engineering Fundamentals", 1st Edition, CRC Press, Boca Raton, Florida, USA, 2013.
5. Saferstein, R., "Criminalistics: An Introduction to Forensic Science", Pearson, 2017.
6. Meloan, C.E., Saferstein, R., "Lab Manual", Pearson, 2003.
7. Hueske, E.E., "Practical Analysis and Reconstruction of Shooting Incidents", CRC Press, 2015.
8. Erickson, E., "Criminalistics Laboratory Manual: The Basics of Forensic Investigation", Routledge, 2017.
9. Heard, B.J., "Forensic Ballistics in Court: Interpretation and Presentation of Firearms Evidence", Wiley – Blackwell, 2013.
10. Hueske, E.E., Bell, S., "Firearms and Fingerprints", Facts on File Scientific Library, 2008.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1					3					
CO2					2					
CO3					3					
CO4					2					
CO5					3	3				
CO6						3		3	2	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3008	Questioned Documents and Finger Print Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. identify the finger prints
2. identify forgery by analyzing the handwriting
3. analyze the footprints

Course Outcomes:

Students will be able to

1. record and classify the fingerprint
2. analyze and study the fingerprint
3. analyze the fingerprint by chemical method
4. analyze the fingerprint by physical method
5. record and study footprints
6. analyze handwriting and identify forgery

LIST OF EXPERIMENTS

1. To take plain and rolled inked fingerprints and to identify patterns
2. To perform ridge tracing, ridge counting and identify the ridge characteristics
3. Comparison of fingerprints
4. To develop latent fingerprints with powder, fuming and chemical methods
5. Lifting of fingerprints
6. Footprint tracing, casting and comparison
7. Bite mark casting and comparison
8. Tire print tracing, casting and comparison
9. Identification of normal / disguise writing
10. Detection of forgeries (traced, simulated and built up)
11. Examination of rubber stamps and other mechanical impressions like seals etc.
12. Examination of type scripts and printed material
13. Examination of alterations, additions, overwriting and obliterations in documents
14. Examination of erasures (mechanical and chemical)
15. Examination of inks by TLC & spectrophotometry
    (Minimum10 experiments to be completed)

Textbooks:

1. Erickson, E., "The Basic of Forensic Investigation", Elsevier Inc., 2014.
2. Evidence Handling & Laboratory Capabilities Guide, Virginia Department of Forensic Science, 2012.
3. Ramotowski, R., "Lee and Gaensslen's Advances in Fingerprint Technology", 3rd Edition, CRC Press, 2013.
4. Bridges, B.C., "Practical Fingerprinting", Funk & Wagnalls, 1963.
5. Alvarez, M.G.P., "Forensic Examination of Questioned Documents", Chapterhouse Publishing Incorporated, Philippines, 2013.
6. Ellen, D., Day, S., Davies, C., "Scientific Examination of Documents – Methods and Techniques", 4th Edition, CRC Press, 2018.
7. Daluz, H.M., "Fingerprint Analysis – Laboratory workbook", Second Edition, CRC Press, 2019.
8. Bleay, S.M., Croxton, R.S., de Puit, M., "Fingerprint Development Techniques", Wiley, 2017.
9. Lee, H.C., Gaensslen, R.E., "Advances in Fingerprint Technology", Second Edition, CRC Press, 2001.
10. Mirakovits, K., Londino-Smolar, G., "The Basic of Investigating Forensic Science – A Laboratory Manual", CRC Press, 2016.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3							3	2	1
CO2					3			2		
CO3					3			2		
CO4					3			2		
CO5	3							2		
CO6					3			2		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3009	Cyber Crime	L	T	P	C

		3	**0**	**0**	**3**

Course Objectives:

Enable the student to

1. understand the types of various storage devices
2. know about cyber forensics
3. understand the principle of cyber crimes

Course Outcomes:

The student will be able to

1. know the principle of operation of computer hardware and accessories
2. understand the types of storage devices
3. know crimes related to computer security
4. analyze computer files
5. understand types of cyber crimes
6. understand the various investigation methods

Unit 1: Parts of the Computer and storage devices (9 Hours)

The computer system and CPU – Types of computers -Binary numbers, digita lsignals, Moore's law, bits & bytes, the binary code, CPU, the microprocessor, the part of progress –Memory – ROM and RAM - Virtual memory – Caches – Buffers – Machine cycle – Registers – Buses for input and output – Adapter cards and multimedia systems – Computer ports – USC and fire wire input an output devices – OCR bar codes – Speech recognition graphics – Scanners – Digitalizing photos and video pointing devices – Pixels and resolution fonts – Range of colour display screens – Image Processing -Types of resolution printers - Secondary storage devices – Storage devices and media – Storage characteristics – Tracks and sectors –Storage media – OS – Application programme user interface – OStypes - File management – Utilities – Document centric computing – Object linking and embedding (ole)- Major software issues – Network computing – Windows – Word processing – Desk top publishing – Internet browsing

Unit 2: Cyberforensics (9 Hours)

Introduction to Cyber Forensics – Storage fundamentals – File systems concepts – Data recovery – CyberForensic Investigation – Investigation tools – eDiscovery – Digital evidence collection – Evidence presentation – Nature of digital evidence, Retrieval and analysis of digital evidence,Sources of digital evidence, Computer security and its relationship to computer forensics E-mail investigation – E-mail tracking – IP tracking – E-mail recovery – Encryption and decryption methods – Search and seizure of computers – Recovering deleted evidence – Password cracking – Formatted partition recovery – Data recovery tools – Data recovery procedures and ethics - Preservation and safe handling of the original media – Chain of custody

Unit 3: Analysis of computer files (9 Hours)

Complete time line analysis of computer files based on file creation – File modification and file access – Recovery of internet usage data – Recovery of swap files / temporary files / cache files – Introduction toencase Forensic Edition – Forensic Tool Kit

Unit 4: Cyber security (9 Hours)

Emergence of computer crime - Classification of computer crimes -Internet – Hacking – Cracking – , computer virus and types, computer worms, Trojan Horse, trap door, super zapping, logic bomb, salami logic, characteristics of computer crimeand criminals.– Virus attacks - Mail Bombs – Bug Exploits – Pornography –Software piracy – Intellectual property – Legal systems of Information Technology – Cyber crime laws –IT laws - Cyber security – Implementing hardware based security – Software based Fire walls – Security standards - Assessing threat levels – Forming an incident response team – Reporting cyber crime – Operating system attacks – Application attacks – Reverse Engineering – Cracking techniques – Financial frauds – Forensic accounting

Unit 5: Investigation (9 Hours)

Investigating on various imaging methods. Lay down the image provided onto a hard disk and provide a disk map of the suspect drive. Extraction of all relevant information from a hard disk. Cell phone/mobile forensics: Introduction, Forensic toolkit, EnCase, Ilook Investigator-Digital signature and cryptography: signature in paper based society, Transfer of computer based documents, digital signature and authentication, digital signature generation and verification, certification of public keys, certification of authority-Brief introduction to Cyber space and cyber Laws, IT Act.

Text Books

1. Johnson, T.A., "Forensic Computer crime Investigation", CRC Press, 2005.
2. Miller, M., "Absolute Beginner's Guide to Computer Basics", CRC Press, 2005.
3. Miller, M., "Easy Computer Basics", Windows Vista Edition, Que, 2008.
4. Atul, J., "Cyber Crime – Issues, Threats and Management (Vol. 1 &2)", Isha Book Publishers, 2005.
5. Britz, M.T., "Computer Forensics and Cyber Crime: An Introduction", Pearson; 1 Edition, 2003.
6. Clark.F., Dileberto, K., "Investigating Computer Crime" CRC Press, 1996.
7. Vacca, J. R., "Computer Forensics – Computer Crime Scene Investigation", 2nd Edition, River Media (Thomson), 2005.
8. Stephenson, P., "Investigating Computer – Related crime", CRC Press, 2000.
9. Casey, E., "Handbook of Digital Forensics and Investigation", Academic Press, 2009.
10. Bayuk, J., "Cyber Forensics: Understanding Information Security Investigations", Springer, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3						3		
CO2	3							3		
CO3		3						3		
CO4					3			3	3	1
CO5		3						3		
CO6					3			3		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3010	Forensic Psychology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. overview of Psychology
2. understand forensic psychology and criminal behavior.
3. learn about tools for nacroanalysis

Course Outcomes:

The student will be able to

1. understand the basics of psychology
2. explain forensic psychology.
3. describe the significance of psychological assessment
4. outline the principles of polygraph
5. describe the procedure for nacroanalysis
6. demonstrate brain electrical oscillation signatures.

Unit 1: Introduction to Psychology (9 Hours)

Psychology – Introduction – Scope and importance – Principles of development – Attention and perception – Process of learning – Memory and forgetting – Motivation – Attitudes – Values of emotions – Behavioural problems – Conflict and use of defense mechanisms – Various types of mental disorders –Psychology of criminal behaviour

Unit 2: Forensic Psychology (9 Hours)

Forensic Psychology and Psychiatry – Narcoanalysis – Polygraphy –Brain fingerprinting -Forensic Psychology and the Law, Ethical Issues in Forensic Psychology, Civil and criminal case assessment, Assessing mental competency, Mental disorders and Forensic Psychology, Eye witness testimony, Criminal profiling- need and types, Forensic Scientific evidence, Crime and Psychopathology, Genetics and Crime, Serial murders, Modus Operandi.

Unit 3: Psychological Assessment (9 Hours)

Psychological Assessment Tools, Detection of deception, Various methods for detection of deception, Interview, Non-verbal detection, statement assessment, Hypnosis, Psychological assessment, voice stress analyzer, Thermal imaging, Brain Electrical Oscillation Signature Profiling, Functional Magnetic Resonance study, Current research in detection of deception/truth finding mechanisms

Unit 4: Polygraph (9 Hours)

Historical aspects of Polygraph, Principles of polygraph, psycho physiological aspects, operational aspects, Question formulation techniques, Interviewing technique procedure, The Art-Polygraph, Legal and Ethical aspects, Human rights of individual.

Unit 5: Narcoanalysis (9 Hours)

Narco-Analysis - Historical aspects, Principle and Theory, General Procedure –Legal and Ethical aspects,Human rights of individual. Brain Electrical Oscillation Signature (BEOS) Profiling - Principle and Theory, General Procedure –Legal and Ethical aspects, Human rights of individual.

Textbooks:

1. Sharma, B.R., "Forensic Science in Criminal Investigation & Trials", Universal Law Publishing – An imprint of LexisNexis, 5th Edition, 2014.
2. Weiner, I.B., Hess, A.K., "The Handbook of Forensic Psychology", John Wiley & Sons; 3rd Revised Edition, 2005.
3. O'Donohue, W., Levensky, E., "Handbook of Forensic Psychology", Academic Press, 2003.
4. Mukundan, C.R., "Brain Experience:Neuroexperiential Perspectives of Brain-Mind", Atlantic; Nil Edition, 2007.
5. Turvey, B., "Criminal Profiling - An Introduction to Behavioral Evidence Analysis", Academic Press, 2011.
6. Niehaus, J., "Investigative Forensic Hypnosis", 1st Edition, CRC Press, 1998.
7. Matte, J.A., "Art and Science of the Polygraph Technique", 1980.
8. Kleiner, M., "Handbook of Polygraph Testing", Academic Press; 1st Edition, 2001.
9. Vrij, A., "Detecting Lies and Deceit: Pitfalls and Opportunities", John Wiley & Sons; 2nd Edition, 2008.
10. Ramachandran, "Law of Narco-Analysis Right Against Self Incrimination", Lawmann's, New Delhi, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3									
CO2							2			
CO3							2			
CO4				2						
CO5					2			3	2	
CO6						3				2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3011	Forensic Serology and Molecular Genetics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of Forensic Serology
2. understand the DNA typing
3. obtain knowledge on bioinformatics

Course Outcomes:

The student will be able to

1. recognize the basic principle of Forensic Serology
2. classify the biological stains
3. understand about serogenic markers
4. summarize about DNA typing and its forensic significance
5. interpret the DNA typing results
6. understand the basics of bioinformatics

Unit 1: Forensic Serology (9 Hours)

Introduction- The nature of blood- Blood stain pattern interpretation and significance-Age of bloodstain- Collection and preservation of blood, semen, saliva, urine, faeces, milk samples- Identification of above biological stains by chemical- Biochemical- Crystal- Chromatographic- Spectroscopic methods-

Determination of origin of species by immunological methods- Methods of grouping biological stains- Secretor and non-secretor status- Identification of menstrual blood, amniotic fluid and parturition stains.

Unit 2: Serogenetic Markers (9 Hours)

Introduction of blood groups- History- Biochemistry and genetics of ABO, MN, Rh, Lewis, Lutheran, Kidd, Duffy and P systems- Serum proteins- KM-GM- HP- GC- Transferrin -Cellular proteins- PGM-AK-ADA-PepA-EsD-GLO-GPT-G6PD- Haemoglobin variants- Hbf – Hbs– Hbc – HbA - Determination of sex and race from blood- White blood group system HLA and its forensic significance.

Unit 3: DNA Typing (10 Hours)

Introduction- Forensic significance - History- Why DNA- Introduction to human genetics-Physical basis of hereditary- Alleles- Population genetics- Molecular biology of DNA- Variation-Enzymes- Collection and Preservation of physical evidence for DNA typing - Forensic DNA Analysis- Isolation of DNA - Determination of quality and quantity of DNA-RFLP analysis- PCR amplification- Types of PCR - Analysis of PCR product- Sequence polymorphism – Length polymorphism - DNA separation – Slab Gel & Capillary Electrophoresis – DNA detection – Fluorescent dyes and silver staining – Instrumentation for STR typing – STR Genotyping – Automated analysis system- Applications of DNA profiling- Legal standards for admissibility of DNA profiling- Future technologies DNA chips, SNPs, DNA cloning

Unit 4: Interpretation of DNA Typing Results (10 Hours)

Introduction to complicating factors- Multiple contributors-Degradation- Extraneous substance- System specific interpretational issues- RFLP based system - Multibanded patterns- Single banded patterns – PCR based systems - Nuclear DNA- Mitochondrial DNA -Determination of genetic concordance- Evaluation of results- Bayes theorem- Hardy Weinberg law-Frequency estimate calculations- Population sub structure- Likelihood rations.

Unit 5:Bioinformatics(7 Hours)

Introduction to bioinformatics, Genomics and Proteomics- DNA databank and database- Certification andAccreditation - role of bioinformatics in forensic science - bioinformatic methods for forensic DNA analyses

Textbooks:

1. Tripathi, A., Dwivedi, A.K., "Forensic Serology & Blood Examination", Selective & Scientific Books, 2012.
2. Kobilinsky, L., "Forensic Chemistry Handbook", Wiley, 2011.
3. Judd, W.J., Rolih, S.D., "Serological Methods in Forensic Science", American Association of Blood Banks, 1985.
4. Butler, J. M., "Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers", Elsevier Academic Press; 2nd Edition, 2005.
5. Rudin, N., Inman, K., "An Introduction to Forensic DNA Analysis", CRC Press; 2nd Edition, 2011.
6. Kirby, L.T., "DNA Fingerprinting: An Introduction", Palgrave Macmillan, 1990.
7. Esteal, S., McLeod, N., Reed, K., "DNA Profiling: Principles, Pitfalls and Potential", Harwood Academic Publishers, 1991.
8. Burns, G.W., "The Science of Genetics: An Introduction to Heredity", Pan Macmillan; 4th Revised Edition, 1980.
9. Gardner, E.J., "Human Heredity", John Wiley & Sons, 1983.
10. Fanger, M.W., Lydyard, P.M., Whelan, A., "Instant Notes in Immunology", Taylor & Francis; 1st Edition, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3									1
CO2				3						
CO3		3								
CO4					3					
CO5						3		3		
CO6		3							2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3012	Forensic Phonetics, Voice Analysis and Speaker Recognition	L	T	P	C

		3	**0**	**0**	**3**

Course Objectives:

Enable the student to

1. understand the basic principle of Phonetics and psycholinguistics
2. understand the procedures involved in voice analysis
3. summarize the various types of speaker recognition methods

Course Outcomes:

The student will be able to

1. recognize the importance of phonetics
2. understand the basics of psycholinguistics
3. understand the methods involved in voice analysis
4. summarize the various types of speaker recognition
5. understand the methods involved in automatic speaker recognition
6. realize the application of voice analysis in forensic science

Unit 1: Introduction to Phonetics (9 Hours)

Introduction, Authentication of tape recordings- Physical examination and laboratory examination, Difficult tapes and transcripts- Enhancing speech- Speech decoding and transcripts- Decoding mechanics, Speaker identification- Ear witness identification- Aural perceptual approaches machine/computer approaches, Vocal behaviours- Stress- Alcohol speech relationships

Unit 2: Psycholinguistics (9 Hours)

Written and spoken utterances as special evidence- Psycholinguistics distinguished-Stylistics- Contribution of psycholinguistics- Identifying authorship- Inferring characteristics of author-Predicting consequence

Unit 3: Voice analysis (9 Hours)

Introduction, Human voice- Nature of voice and production of speech- Perception of voice and speech, Collection of evidence, Quality of evidence- Types of evidences - Speaker variability and simulation- Transmission channel distortion- Recording system distortion - Admissibility

Unit 4:Speaker recognition (9 Hours)

Types- Procedure and methods - Feature extraction - Feature comparison – Classification, Speaker recognition by listening - Recognition by non-experts and experts, Speaker recognition by visual comparison of spectrograms- Technology- Kersta method- Tosi study

Unit 5: Automatic speaker recognition (9 Hours)

Feature extraction – Feature comparison and normalization techniques- Interpretation of results, Speaker profiling, Intelligibility enhancement of audio recordings, Transcription & analysis of disputed utterances- Authenticity and integrity examination of audio recordings

Textbooks:

1. Ladefoged, P., Johnson, K., "A Course in Phonetics", Wadsworth Publishing Co Inc; 7th Edition, 2014.
2. Ashby M., Maidment, J., "Introducing Phonetic Science", Cambridge University Press, 2005.
3. Steinberg, D.D., "An Introduction to Psycholinguistics", Addison Wesley Publishing Company, 1995.
4. Sedivy, J., "Language in Mind: An Introduction to Psycholinguistics", Sinauer Associates (An Imprint of Oxford University), 2014.
5. Maher, R.C., "Principles of Forensic Audio Analysis", Springer, 2018.
6. Hollien, H., "Forensic Voice Identification", Academic Press, 2001.
7. Zhang, D., Wu, K., "Pathological Voice Analysis", Springer; 1st Edition, 2020.
8. Beigi, H., "Fundamentals of Speaker Recognition", Springer, 2011.
9. Li, J., Deng, L., Haeb-Umbach, R., Gong, Y., "Robust Automatic Speech Recognition – A Bridge to Practical Applications", Elsevier, 2015.
10. Yu, D., Deng, L., "Automatic Speech Recognition: A Deep Learning Approach (Signals and Communication Technology)", Springer, 2015.

	PO 1	PO2	PO 3	PO4	PO5	PO 6	PO 7	PSO 1	PSO2	PSO 3

CO1	3									
CO2		3								
CO3		3						3	2	
CO4		3								1
CO5							3			
CO6						3				

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3013	Microscopy in Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of light microscopy
2. realize the importance of electron microscope
3. summarize the types of photomicrography

Course Outcomes:

The student will be able to

1. understand the properties of light
2. summarize the principles of microscopy
3. realize the principles of various types o light microscopy
4. understand the principles of SEM
5. understand the principles of TEM
6. understand the principles of photo micrography

Unit 1: Introduction to Microscopy (9 Hours)

Electromagnetic radiation – Properties of Light – Magnification – Resolution – Resolving Power – Depth of field – Depth of focus – Numerical aperture – Lens – Aberration of Lenses

Unit 2: Light Microscopy – I (9 Hours)

Principle of bright field and dark field microscopy – Theory, Principles and working of compound microscope – Comparison microscope – Stereomicroscope – Fluorescence Microscope – Polarizing Microscope –Phase contrast Microscope

Unit 3: Light Microscopy – II (9 Hours)

Theory, Principles and working of interference microscope – Confocal microscope – Oil immersionmicroscope – Ultraviolet microscope – Infra-red microscope – X-ray microscope

Unit 4: Electron Microscope (9 Hours)

Introduction-Historical view – types – Scanning Electron Microscopy – Theory and Principles – Specific feature – instrumentation – sample preparation – specimen interaction volume – signal produced by specimen and forensic applications - Transmission Electron Microscopy – Theory and Principles – instrumentation – Forensic applications – Comparison of SEM and TEM – Comparison of Light microscopy and Electron Microscopy

Unit 5: Miscellaneous Microscopy (9 Hours)

Photomicrography – Introduction, Principles and procedure of photomicrography – UV Photography – Infra red photography – Microphotography – Comparison of Light microscopy and photomicrography – Principles and applications of Magnetic Resonance Microscope – Scanning Probe Microscope – Ultrasonic microscope

Textbook:

1. Bell, S., Morris, K., "An Introduction to Microscopy", 1st Edition, CRC Press, 2009.
2. Murphy, D.B., "Fundamentals of Light Microscopy and Electronic Imaging", Wiley-Blackwell, 2001.
3. Chiarini-Garcia, H., Melo, R., "Light Microscopy – Methods and Protocols", Springer, 2011.
4. Sanderson, J., "Understanding Light Microscopy", John Wiley & Sons, 2019.
5. Egerton, R.F., "Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM", 2nd Edition, Springer, 2016.
6. Wheeler, B., Wilson, L.J., "Practical Forensic Microscopy: A Laboratory Manual", Wiley-Blackwell, Lab Manual Edition, 2008.

7. Encyclopedia of Analytical Chemistry, Wiley, 2006.
8. Overney, N., Overney, G., "The History of Photomicroscopy", 3rd Edition, 2011.
9. Davies, A., "Digital Ultraviolet and Infrared Photography (Applications in Scientific Photography)" Routledge, 1st Edition, 2017.
10. Basu, S., Millette, J.R., "Electron Microscopy in Forensic, Occupational, and Environmental Health Sciences", Plenum Press, 1986.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3								
CO2						3				
CO3		3						3	2	1
CO4		3								
CO5		3								
CO6		3								

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3014	Biological Instrumental Methods	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle biological analysis
2. realize the importance of centrifugation techniques
3. apply the methods for enzyme kinetics

Course Outcomes:

The student will be able to

1. understand the principle biological analysis
2. summarize the principles of centrifugation techniques
3. realize the techniques used in enzyme kinetics
4. understand the principles of immunochemical methods
5. understand the cloning procedures
6. understand the methods involved in specific nucleic acid sequences

Unit 1: General principles of Biological Analysis

physiological solution, Cell and Tissue Culture, Cell fractionation, Biological variation etc.

Unit 2: Centrifugation Techniques

Basic principles of sedimentation, Types of centrifuges, Density gradient centrifugation, Prerogative centrifugation, Analysis of sub-cellular fractions, ultracentriguge, refrigerated centrifuges.

Unit 3: Enzyme Techniques (9 Hours)

Enzyme kinetics, purification and protein estimation, enzyme assay techniques, visible UV spectrophotometric methods, Luminescence method, Radioisotope methods, Immuno-chemical method, automated enzyme analysis, immobilized enzymes.

Unit 4: Immunochemical Techniques (9 Hours)

General principles, production of antibodies, precipition reaction, Gel immunodiffusion, Immune-electrophoresis, complement fixation. Radio immunoassay (RIA), enzyme immunoassay, metalloimmunoassay, chemiluminiscent/fluorescence immunoassay.

Unit 5: Molecular Biology Techniques (9 Hours)

Outline of genetic manipulation enzyme, Enzymes and in genetic manipulation, cloning procedures, Isolation of specific nucleic acid sequences-complimentary DNA, Gene libraries, colony hybridization, Nick translation, oligonucleotide probes, expression of genes.

Textbooks:

1. Gordon, M.H., "Instrumental Analysis in the Biological Sciences", Springer, 1987.
2. Rao, D.M., Swamy, A.V.N., Reddy, D.D., "Instrumental Methods of Analysis", CBS Publication, 2012.
3. Bajpai, P.K., "Biological Instrumentation & Methodology", S. Chand & Company, 2010.
4. Naidoo, S., "Centrifugation Techniques", Arcler Education Incorporated, 2017.
5. Rickwood, D., "Centrifugation, a practical approach", Information Retrieval, 1978.

6. Khan, M.Y., Farha, K., "Principles of Enzyme Technology", PHI Learning Pvt Ltd, 1st Edition, 2015.
7. Goers, J., "Immunochemical Techniques Laboratory Manual", Academic Press; Spi Edition, 1993.
8. Burns, R., "Immunochemical Protocols", Humana Press, 2010.
9. Suraksha, A., "Techniques in Molecular Biology", Ibdc Publishers, 2008.
10. Miller, H., Witherow, D.S., Carson, S., "Molecular Biology Techniques: A Classroom Laboratory Manual", Academic Press, 3rd Edition, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3								
CO2						3				
CO3							3	3	2	1
CO4		3								
CO5		3								
CO6		3								

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3015	Statistics and Forensic Applications	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. understand the basics of statistics
2. realize the concept of probability
3. know about statistical approach to evaluation of results

Course Outcomes:

The student will be able to

1. understand the importance of statistics in interpreting forensic data
2. know about concept of probability
3. understand about various analytical tests
4. understand the concept of analysis of variance
5. understand the various types of databases
6. acquire knowledge about evaluation of evidence

Unit 1: Fundamentals of Statistics (6 Hours)

Statistics: Definition – Importance of statistics in interpreting forensic data in research work and quality control – Data – Population – Distribution – Location - Random experiment - Brief introduction to sampling and data collection - Frequency distribution - Concept of measures of central tendencies - Normal distribution - Arithmetic mean - Median & Mode concept of measures of dispersion – Variance -Normal distribution- Variance, Standard Deviation, Coefficient of variation.

Unit 2: Probability (6 Hours)

Definitions of probability – Discrete random variables and probability distributions -Addition, multiplication and Bayer's theorem & applications – Probability in Forensic Evidence - Concept of random variable - Discrete and continuous – Some examples, Concept of probability distribution – Binomial - Poisson - Normal distribution – Definitions, statements of propertiesof above distribution and examples - Simple linear regression and correlation – Concept of computationalmethodology – Examples - Concept of tests of hypothesis – Null and alternative hypothesis – Critical region - Types of errors & level of significance

Unit 3: Sample tests (6 Hours)

Large samples tests – Test for single mean, Difference of means, Single proportion and difference of proportion examples - Chi square test for goodness of fit and test for independence of attributes – Examples - Hypothesis testing for one or two population means - Student t-test - t-test for simple mean - Difference of means – Examples. Hypothesis testing for small sample sizes and multinomial experiments

Unit 4: Variance (6 Hours)

Fisher's exact test- Analysis of variance and multiple comparison tests - F-test for equality of variance – Examples - Concept of analysis of variance – Computational procedure for ANOVA one way and two way classification- Examples.

Unit 5: Scientific evidence and statistics (6 Hours)

Data Bases – Type and geographical factors –Statistical approach to DNA fingerprinting – Loci and alleles - Simple case genotypic frequencies – Hardy Weinberg equilibrium – Simple case of allelic frequencies – Accounting for sub-population – Paternity mother and father unrelated – Data base searches and value of evidence- Evidence evaluation examples – Blood group frequencies – Clothing fibres – Shoe types – Air weapon projectiles – Height identification from eye witnesses - Uncertainty in scientific experimentation – Determination of uncertainty

Textbooks:

1. Lucy, D., "Introduction to Statistics for Forensic Scientists", 1st Edition, Wiley, 2005.
2. Aitken, C., Taroni, F., "Statistics and the Evaluation of Evidence for Forensic Scientists", Wiley, 2nd Edition, 2004.
3. Fung, W.K., Hu, Y., "Instrumental DNA Forensics: Theory, Methods and Computation", Wiley, 1st Edition, 2008.
4. Evett, I.W., Weir, B.S., "Interpreting DNA Evidence: Statistical Genetics for Forensic Scientists", Sinauer Associates Inc., 1st Edition, 1998.
5. Miller, J.C., Miller, J.N., "Statistics for Analytical Chemistry", Ellis Horwood Ltd., Subsequent Edition, 1993.
6. Fisher, R.A., "Statistical Methods for Research Workers", Cosmo Publications, New Delhi, 2006.
7. Sokal, R.R., Rohlf, F.J., "Biometry: The Principles and Practices of Statistics in Biological Research", W. H. Freeman; 3rd Edition, 1994.
8. Rao, T.B., "Methods of Biostatistics", Paras Medical Publisher; Third Edition, 2001.
9. Ramakrishnan, P., "Biostatistics", Saras Publication, 2015.
10. Rao, K.V., "Biostatistics a Manual of Statistical Methods for Use in Health, Nutrition and Anthropology", Jaypee Brothers Medical Publishers, Ssecond Edition, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3								
CO2						3		3	2	1
CO3		3								
CO4		3								
CO5		3								
CO6							3			

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3016	Molecular Biology & Immunology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand about gene expression
2. know about the organization of immune system
3. know about immune technology

Course Outcomes:

The student will be able to

1. understand the fundamental concepts of regulation of genes
2. know the role of DNA in biological systems
3. understand the concept of immunity
4. know about vaccines and types
5. understand about Antigen-Antibody interaction
6. acquire knowledge about Generation of Polyclonal antibodies

Unit 1: Regulation of gene expression (9 Hours)

– Regulation by operons in prokaryotes – lac operon – Catabolite repression – Attenuation – prompter flipping – Central dogma and levels of gene regulation by chromatin remodeling **–** Transcriptional regulation by transcription factors – Post transcriptional regulation by alternate splicing – Translational regulation – Post translational modifications to modulate gene productactivity

Unit 2: Recombinant DNA technology(9 Hours)

Overview of cloning – History of rDNA technology – Bacterial and eukaryotic vectors – Restriction enzymes for production recombinant DNA – Polymerases, kinase and ligase for production of recombinant DNA – Preparation of cDNA and genomic DNA libraries – Screening to select clone of interest – Over expression of cloned proteins in bacteria – Production of transgenic animals – production of transgenic plants – Silencing using RNAi

Unit 3: Immunology (9 Hours)

Organization of the immune system – Haematopoiesis – Production and differentiation of the immune cells - Cells of the immune system – Primary and secondary lymphoid organs – Innate immunity – Specific acquired immunity – Active and passive immunity - Cell mediated immunity – Humoral immunity

Unit 4: Immunoglobulin (9 Hours)

Structure of a typical immunoglobulin - Classes of immunoglobulins – Genetics of Antibody production – Generation of Antibody diversity - Antigens and immunogens – Super antigens - Auto immune disorders – Blood group antigens – Vaccines and their types

Unit 5: Immunotechnology (9 Hours)

Antigen-Antibody interaction - Precipitation and agglutination of the Ag –Ab – Mancicni's Radial immunodiffusion - Ouchterlony's Double diffusion – Haemagglutination – Agglutination inhibition – Passive agglutination - Immuno electrophoresis – Rocket immune electrophoresis – RIA – ELISA – Western blot – Complement fixation test – Inhibition of complementfixation – Direct and indirect Coomb's test - Immediate and delayed Hypersensitivity – Generation ofMonoclonal antibodies – Generation of Polyclonal antibodies – Abzymes

Textbooks:

1. Kindt, T. J., Osborne, B.A., Goldsby, R.A., "Kuby Immunology", W. H. Freeman & Company; 6th Edition, 2006
2. Roitt, I., "Essential Immunology", Wiley-Blackwell; 8th Edition, 1994.
3. Nelson, D.L., Cox, M.M., "Lehninger Principles of Biochemistry", W H Freeman & Co, 6th Edition, 2012.
4. Glick, B.J., Pasternak, J. J., Patten, C.L., "Molecular Biotechnology: Principles and Applications", American Society for Microbiology, 4th Edition, 2010.
5. Watson, J.D., Baker, T.A., Bell, S. P., Gann, A., Levine, M., Losick, R., "Molecular Biology of the Gene", Pearson, 7th Edition, 2013.
6. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D., "Molecular Biology of the Cell", Garland Science, 3rd Edition, 1994.
7. Brown, T.A., "Gene Closing and DNA Analysis: An Introduction", 6th Edition, Wiley-Blackwell, 6th Edition, 2010.
8. Gaensslen, R.E., "Sourcebook in Forensic Serology, Immunology, and Biochemistry", University of Michigan Library, 1983.
9. Chakravarthy, A.K., "Immunology and Immunotechnology", Oxford University Press, 1st Edition, 2006.
10. **Rastogi, S.C., "**Elements of Immunology", CBS Publication, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3						3	2	1
CO2							3			
CO3		3								
CO4							3			
CO5							3			
CO6							3			

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3017	Medical Jurisprudence	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand about legal procedures in Courts
2. know about personal identity

3. know about post-mortem examination

Course Outcomes:

The student will be able to

1. know about various legal procedures
2. know about the pparameters contributing to personal identity
3. understand the importance of post-mortem examination
4. know about wounds
5. understand the modes of death
6. acquire knowledge to estimate time since death

Unit 1: Concept of Medical Jurisprudence (8 Hours)

Brief knowledge about legal procedures in Courts, inquest, Criminal courts and their powers, Subpoena & oath of medical expert. Recording of Medical experts evidence in courts. Types of Medical evidence. Kinds of witness and rules for giving evidence.

Unit 2: Personal Identity: (8 Hours)

Definition and importance. Parameters contributing to personal identity- Race, Sex, Age, Complexion, features & Photographs, Anthropometry, Fingerprints, Footprints, Tattoo marks, Occupational marks, Handwriting, Clothes & Ornaments, Voice & Speech, DNA, Superimposition techniques for skull. Disputed paternity.

Unit 3: Post-Mortem Examination: (9 Hours)

Importance, post-mortem report format, external & internal examination in brief. Viscera & its preservation. Examination of decomposed and mutilated bodies. Precaution to be taken during post mortem examination. Exhumation. Cause of death.

Unit 4: Wounds (10 Hours)

Wounds & its types, Medico-legal aspects, post mortem & ante mortem wounds, General characteristics of injuries from burns, scalds, lightning, electricity and radiation. Forensic importance of wounds.

Unit 5: Deaths in its Medico-legal aspects (10 Hours)

Modes of Death (Coma, Syncope, Asphyxia), Sudden death. Sign of Death, cessation of vital functions, changes in the Eye & Skin, cooling of body, post-mortem lividity, cadaveric changes in the muscles, putrefaction, adipocere & mummification. Estimation of time since Death.

Textbooks:

1. Kannan, K., "Modi's A Textbook of Medical Jurisprudence and Toxicology", Lexis Nexis Butterworth India, 2019.
2. Smith, F.J., "Taylor's Principles and Practice of Medical Jurisprudence. Volume 2 of 2", Gale, Making of Modern Law, 2010.
3. Parick, C.K., "Parikh's Textbook of Medical Jurisprudence, Foresic Medicine and Toxicology", CBS, 6th Edition, 2007.
4. Knight, B., "Simpson's Forensic Medicine", CRC Press, 11th Edition, 1996.
5. Polson, C.J., Gee, D.J., "The Essentials of Forensic Medicine", Pergamon, 4th Revised Edition, 1984.
6. Reddy, K. S. N., Murthy, O.P., "The Essentials of Forensic Medicine and Toxicology", Jaypee Brothers Medical Publishers, 34th Edition, 2017.
7. Aggarwal, A., "APC Textbook of Forensic Medicine and Toxicology", Avichal Publishing Company, Delhi, 2014.
8. Biswas, G., "Practical and Postmortem Record Book of Forensic Medicine and Toxicology", Jaypee Brothers Medical Publishers, First Edition, 2016.
9. Wilson, K.D., "Cause of Death : A Writer's Guide to Death, Murder and Forensic Medicine", Writers Digest Books, 1st Edition, 1992.
10. Joseph, M., Kaur, H., "A Handbook of Forensic Medicine and Toxicology: Question Answer Format with Illustrations", B. Jain Regular, First Edition, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3									
CO2	3									
CO3		3								
CO4	3									

CO5		3								
CO6						3		3	2	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3018	Human Anatomy, Physiology and Forensic Medicine	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand about human physiology and anatomy
2. know about the forensic medicine and pathology
3. understand about the causes of unexpected natural deaths

Course Outcomes:

The student will be able to

1. understand human anatomy
2. summarize about human physiology
3. understand about the forensic medicine
4. understand the basics of Forensic pathology
5. summarize about the sexual offences and forensic science
6. analyse the reasons for unexpected death

Unit 1:Human Anatomy and Physiology (10 Hours)

Structural levels of organization of human body – Cardiovascular system - Structure and Functions of heart - Arterial & Venous system - Digestive system and its parts - Process of digestion and absorption of food in the alimentary canal - Respiratory system and its parts - Mechanism and regulation of respiration –Nervous system – Structure and functions of neuron – Transmission of nerve impulse - Central and Peripheral Nervous systems and their functions – Endocrine system - Characteristics of hormones - Endocrine glands and their hormones - Urinogenital system - Structure and functions of kidneys - Formation and composition of urine - Male and female reproductive systems and their functions

Unit 2: Forensic Medicine (9 Hours)

Forensic Medicine – Personal identification of living and dead – Postmortem examination (autopsy) – Medico legal aspects of death – Causes of death - Postmortem changes and their importance in determination of time after death - Mechanical injuries – Thermal injuries – Medico legal aspects of injuries

Unit 3: Forensic pathology (9 Hours)

Preservation of pathological evidence - Examination of decomposed, mutilated and burnt bodies – Exhumation procedure - Deaths from poisoning – Mechanical Asphyxia – Drowning - Starvation - Lightning – Electrocution

Unit 4: Sexual offences (8 Hours)

Rape – Unnatural sexual offences and medicolegal aspects - Abortion & Infanticide –Medico legal aspects – Impotence and sterility – Virginity, Pregnancy and Delivery - Medicolegal aspects - MPT Act - Linkage with forensic science laboratory

Unit 5: Unexpected deaths due to natural causes (9 Hours)

Causes of sudden and unexpected deaths – carduiovascular system – respiratory system – gastrointestinal system – Gynaecological conditions – Deaths from asthma and epilepsy

Textbookss:

1. Pillay, V.V., Handbook of Forensic Medicine and Toxicology, 12th ed., Paras Publication2001.
2. Modi, J. P., Textbook of Medical Jurisprudence & Toxicology , M.M. Tripathi Publication, (2001)
3. Parikh, C.K. , Textbook of Medical Jurisprudence & Toxicology
4. Reddy Narayn,. M., Textbook of Medical Jurisprudence & Toxicology
5. James, P.J.: Encyclopedia of Forensic and Legal Medicine, Elsevier, 2005
6. Shepherd R. "Simpson's Forensic Medicine", 12th Edition,A Hodder Arnold Publication, 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2	1		2	2		1	1	
CO2	2	1		2	2	1		1	1	

CO3	3	2	1	2		2	1	1	2	
CO4	3		2	2	2	1	1	2	2	2
CO5	3	2	3	2		3	2	1	2	3
CO6	2	3	1	3	1	1	1		3	2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-‘ No correlation