दिल्ली विश्वविद्यालय
UNIVERSITY OF DELHI

Bachelor of Science (Prog.) Applied Life Science with Agro Chemicals and Pest Management

(Effective from Academic Year 2019-20)

Revised Syllabus as approved by
Academic Council
Date: 15 & 16 July 2019 No:
Executive Council
Date: 20 & 21 July 2019 No:

Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning

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Preamble

The objective of anyprogramme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour, it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. Prog. Applied Life Sciences with Agro Chemicals and Pest Management offer courses in the areas of inorganic, organic, physical, analytical and agrochemicals. All the courses are having defined objectives and Learning Outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offers ample skills to pursue research as career in the filed of chemistry and allied areas. As usual, B.Sc. Prog. Applied Life Sciences with Agrochemicals and Pest Management programme offered by one of the largest and oldest Departments in the country will continue to produce best minds to meet the demands of society.

The University of Delhi hopes the LOCF approach of the programmeB.Sc. Prog. Applied Life Sciences with Agrochemicals and Pest Management will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

1. Introduction:

The Learning outcomes-based curriculum framework is designed around the Choice-Based Credit System (CBCS) and is intended to suit the present day needs of the student in terms of securing their path towards higher studies or employment. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. The uniform grading system will also enable potential employers in assessing the performance of the candidates. The Choice-Based Credit System (CBCS) provides an opportunity for the students to choose courses from the prescribed courses comprising of:
Core Course: compulsory course studied by a candidate as a core requirement is termed as a Core course.

1. **Elective Course:** A course which can be chosen from a pool of courses and which may be very specific or specialized subject of study which enables an exposure to some other discipline/ subject is called an Elective Course.
   2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.
   2.2 Dissertation/ Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2. **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.
   3.1 AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Comm.
   3.2 AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

Programme Duration and Design:

The B.Sc. Programme with Agrochemical and Pest Management (ACPM) will be of three years duration. Each year will be called an academic year and will be divided into two semesters. Thus there will be a total of six semesters. Each semester will consist of sixteen weeks. The teaching-learning will involve theory classes (Lectures) of one hour duration and four hour practical classes. The curriculum will be delivered through various methods including chalk and talk, power point presentations, audio, video tools, E-learning/E-content, virtual labs, simulations, fieldtrips/Industry visits, seminars (talks by experts), workshops, projects, models and class discussions. Assessment will be based on continuous evaluation (class test, presentation, group discussion, quiz, assignment, etc.) and end of semester examination. Each theory paper will be of 100 marks out of which 25% marks are reserved for internal assessment while a practical paper will be of 50 marks comprising 50% internal assessment.

2. Learning Outcome-based Curriculum Framework in BSc ALS with ACPM:

The Learning Outcomes-based Curriculum Framework (LOCF) for the B.Sc. Programme Agrochemicals and Pest Management is designed to allow the flexibility in programme design and course content development, while at the same time maintaining a basic uniformity in the structure in comparison with other Universities across the country. The B.Sc. Programme ACPM covers a wide range of basic and applied courses in the fields of Botany, Zoology and Chemistry covering the areas like Agricultural Botany, Immunology, Molecular Biology, Inorganic Chemistry, Organic Chemistry, Physical Chemistry and many more. The core courses that are a part of the programme are designed to build a strong knowledge base in the fields already mentioned so that the student gets acquainted with the all aspects of this interesting course. The student is thus equipped to pursue higher studies in an institution of her/his choice, and to apply the skills learnt in the programme in solving the practical problems. The programme offers a wide range of elective and skill enhancement courses to the student. The well-designed papers and the exhaustive training in the diverse fields help them to explore prospect in the higher studies and the jobs in academia or industry.

3. Graduate Attributes in in BSc ALS with ACPM:

Some of the characteristic attributes of graduate in B.Sc. Programme Agrochemicals and Pest Management include:

i. **Disciplinary Knowledge:**Gathers in-depth knowledge of basic and applied areas of ACPM.
ii. **Communication skills**: Develops effective communication skills through oral presentations of on-going developments in the field and the compiling of information in the form of reports.
iii. **Laboratory skills**: Understands and becomes conversant with various methods of safer handling of chemicals, biological specimens and various scientific equipments.
iv. **Interdisciplinary approach:** Becomes aware of the synchronization of the main scientific fields viz. Chemistry, Botany and Zoology and its application in the daily life.
v. **Environmental literacy**: Develops a basic understanding of the Chemistry, Botany and Zoology principles that have environmental implications, gains an awareness of environmental safety like safer handling of chemicals in the laboratories, their safe disposal and replacement of harsh chemicals with the safer and environmental friendly options.
vi. **Scientific logic**: Develops a scientific logic and approaches a problem with critical reasoning.
vii. **Independence in thought**: Cultivates independent thinking and is able to integrate the knowledge from all the diverse fields for its maximum application in the real world.
viii. **Team work:** Understands the importance and strengths of interacting with and working alongside people from diverse backgrounds with a meaningful contribution to team ethos and goals.
ix. **Awareness of ethical issues:** Is aware of what constitutes unethical behaviour-plagiarism, fabrication and misrepresentation or manipulation of data.
x. **Ethics**: Acquires an awareness of work ethics and ethical issues in scientific research as well as plagiarism policies.
xi. **Self-motivation:** Develops self-discipline, planning and organization skills, and time management skills.
xii. **Research oriented:** Is inquisitive about processes and phenomena happening during experiments in laboratories and seeks answers through the research path.

4. Qualification description for graduates in BSc ALS with ACPM:

The qualification description for B.Sc. Programme in Agrochemicals and Pest Management includes:

- Demonstration of a comprehensive knowledge of the basic concepts, principles and theories of the fields- Chemistry, Botany, Zoology, Agriculture & Pest management and an awareness of the emerging areas/topics of these fields.
- Enhancement of ability to read, assimilate and discuss scholarly articles and research papers of the mentioned diverse fields of sciences with a sense of interdisciplinary scenario.
- Acquisition of practical laboratory skills, enabling the systematic collection of experimental data of all the three fields and correlating them to accurately design an experiment.
- Ability to analyse and interpret experimental data and maintain records of the same.
- Development of literature searching and information management skills.
- Development of strong oral and written communication skills promoting the ability to present the studies in all the three fields by using the concepts and knowledge acquired.
- Development of awareness of the role of Chemistry, Botany, Zoology, Agriculture & Pest management in contemporary societal and global issues, including areas such as sustainability and green chemistry and environmental science.
- Demonstration of the ability to work effectively and productively, independently or as part of a team.
- Development of competence in intellectual, practical and transferable skills (Communication and Interpersonal skills) necessary for employment as a professional scientist.

5. Programme learning outcome in BSc ALS with ACPM:

Students of B.Sc. programme in Agrochemicals and Pest Management (ACPM) are develop in depth knowledge of the core concepts and principles of Agrochemical and Pest Management. Undergraduates pursuing this programme of study go through laboratory work that specifically develops their quantitative and qualitative skills, provides opportunities for critical thinking and team work and exposes them to techniques useful for applied areas of scientific study.

- **Knowledge, Depth and Width**: Students acquire sound theoretical knowledge and understanding of the fundamental concepts, principles and processes in Agrochemical and Pest Management. Depth in understanding is the outcome of transactional effectiveness and treatment of specialized course contents. Width results from the choice of electives that students are offered.
- **Instrumental technique**: A much valued learning outcome of this programme is the laboratory skills that students develop during the course. The techniques gained through hands- on methods opens a choice of joining the industrial laboratory work force after graduation. The programme also provides an ample training in handling basic chemical and biological laboratory instruments and their use in the interfacial scientific determinations. Undergraduates on completion of this

programme can cross branches to join pharmaceutical, material testing laboratories besides agrochemicals, pest management labs.

- **Communication**: Communication is a highly desirable attribute to possess. Opportunities to enhance student's ability to write methodical, logical and precise reports are inherent to the structure of the programme. Techniques that effectively communicate scientific content to large audiences are acquired through oral and poster presentations and regular laboratory report writing.

- **Capacity Enhancement**: Modern day scientific environment requires students to possess ability to think independently as well as be able to work productively in groups. This requires some degree of balancing. The ACPM course is designed to take care of this important aspect of student development through effective teaching learning process.

- **Portable Skills**: Besides communication skills, the programme develops a range of portable or transferable skills in students that they can carry with them to their new work environment after completion of ACPM programme. These are problem solving, information retrieval skills and organizational skills. These are valued across work environments.

6. Structure of the Programmein BSc ALS with ACPM:

To acquire a B.Sc. programme with Agrochemical and Pest Management (ACPM) degree, **the student will study twelve Core Courses, six Discipline Specific Elective Courses, four Skill Enhancement Courses and two Ability Enhancement courses.**The Core Courses and Discipline-Specific Electives are six credit courses. The Skill Enhancement Course and Ability Enhancement courses are four-credit courses. A student has to earn a minimum of 132 credits to get a degree in B.Sc. Agrochemical and Pest Management (ACPM). The student will study four Core Courses from each discipline in Semesters I, II, III and IV; two Discipline Specific Elective Courses from each discipline in Semesters V and VI; one Skill Enhancement Course in Semester III, IV, V and VI. And two compulsory Ability Enhancement Courses are Environmental Sciences and English Communication and the student will study one each in Semesters I and II.

SCHEME OF B.Sc. PROGRAMME (APPLIED LIFE SCIENCES WITH AGRO-CHEMICALS AND PEST MANAGEMENT)

Semester	CORE COURSE (12)*	Ability Enhancement Compulsory Course (AECC) (2)*	Skill Enhancement Course (SEC) (4)*	Elective: Discipline Specific DSE (6)*
I	Core course Botany –I Core course Zoology- I Core course Chemistry- I	AECC-1		
II	Core course Botany –II Core course Zoology- II Core course Chemistry- II	AECC-2		
III	Core course Botany –III Core course Zoology- III Core course Chemistry- III		SEC-1	
IV	Core course Botany –IV Core course Zoology- IV Core course Chemistry-IV		SEC-2	
V			SEC-3	DSE-1, DSE-2, DSE-3
VI			SEC-4	DSE-4, DSE-5, DSE-6

*Number of courses student has to study

6.1 Semester-wise Distribution of Courses and Credit distribution for B.Sc. Applied Life Science(ALS) with Agro Chemicals and Pest Management (ACPM)

SEM.	COURSE CODE	NAME OF THE COURSE	CREDITS L=Lecture; P=Practical
Core Courses –12 papers			
	BOTANY – C I	Biology of Life Forms: Plants	L=4 P=2
	CHEMISTRY – C I	Inorganic Chemistry	L=4 P=2
	ZOOLOGY-C I	Animal: Form, Structure and Function	L=4 P=2
	BOTANY – C II	Agricultural Botany and Weed Science	L=4 P=2
	CHEMISTRY – C II	Organic Chemistry -1	L=4 P=2
	ZOOLOGY-C II	Cell and Cellular Processes	L=4 P=2
	BOTANY – C III	Fundamentals of Plant Systematics and Ecology	L=4 P=2
	CHEMISTRY – C III	Physical chemistry	L=4 P=2
	ZOOLOGY-C III	Biochemistry and Immunology	L=4 P=2
	BOTANY – C IV	Developmental Biology: Plants	L=4 P=2
	CHEMISTRY – C IV	Organic Chemistry-2	L=4 P=2
	ZOOLOGY-C IV	Molecular Biology and Development Biology	L=4 P=2
			Credits: 12× 6 = 72
Discipline Specific Elective Courses (DSE) – 6 papers*			
		Genetics and Plant Biotechnology	L=4 P=2
		Plants regulators and Economic Botany	L=4 P=2
		Dissertation	6
		Soils and Fertilizers	L=4 P=2
		Herbicides	L=4 P=2
		Fungicides	L=4 P=2
		Dissertation	6
		General Entomology	L=4 P=2
		Applied Entomology	L=4 P=2
		Integrated Pest Management	L=4 P=2
		Dissertation	6
			Credits: 6× 6 = 36
Skill Enhancement Elective Courses (SEC) – Any 4 papers			
		Medicinal Plants and IPR	L=2 P=2
		Plants Quarantine	L=2 P=2
		Plant Health Diagnostics and Management	L=2 P=2
		Plants Regulators and Economic Botany	L=2 P=2
		Conventional Insecticides	L=2 P=2
		Biological Insecticides	L=2 P=2
		Pesticide Formulations	L=2 P=2
		Analytical Techniques involved in Pesticide Analysis	L=2 P=2
		Biotechnological Control of Pest	L=2 P=2

		Biological Control	L=2 P=2
		Insect Toxicology	L=2 P=2
		Quality Control in IPM	L=2 P=2
		Use of Nuclear Technology for Agro-Pest Management	L=2 P=2
			Credits: 4× 4 = 16
Ability Enhancement Courses (AEC)			
	AEC-I	Environmental Science	L = 4
	AEC-II	English Communication	L = 4
			Credits: 2×4 = 08
Total 132			

***Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester.**

Note: Wherever there is a practical there will be no tutorial and vice-versa. The size of the group for chemistry practical papers is recommended to be maximum of 15 to 20 students.

7. **Teaching-learning process:**

B.Sc. programme in Agrochemicals and Pest Management (ACPM) aims to make the student proficient in theoretical background and practical training in the related field. It also helps them to develop an appreciation of the importance of ACPM in different contexts through the exposure to the spectrum of the knowledgeable and facts in this field. For this, an exhaustive training in the classroom and laboratory is given.In the classroom, this will be done through the lectures delivered using both conventional methods and smart technology. The protocol may vary from using blackboard/ whiteboard to the power-point presentations with the inclusion of the information from internet viz. animations. So the different pedagogies such as problem-based learning, peer-led instruction, and technology-aided instruction (blended learning) are adopted wherever suitable. Like in the interactive mode of teaching, the student will be encouraged to participate in discussions and deliver presentations on the relevant topics.

In the laboratory, the student will first learn good laboratory practices and then get hands-on training on basic techniques and methods adopted for simple synthesis and characterization of agrochemicals. The student will participate in field trips to industries that give an insight to the future areas of the employment.

8. Assessment methods:

The student will be assessed over the duration of the programme by many different methods. These include short objectives-type quizzes, assignments, written and oral examinations, group discussions and presentations, problem-solving exercises, case study presentations, experimental design planning, execution of experiments, seminars, preparation of reports, and presentation of practical records. The wide range of assessment tasks aim to break the monotony of having a single assessment method.

CHEMISTRY - C I: INORGANIC CHEMISTRY (Core Course Chemistry)

Total Credits: 06 (Credits: Theory-04, Practical-02)
(Total Lectures: Theory- 60, Practical-60)

Objective:

This course provides an in-depth understanding about the structure of an atom, which is a necessary prerequisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic and covalent bonding and structures of important hetero nuclear - and homo nuclear -diatomic molecules on the basis of MO theory. This course will also provide an insight into general principles of metallurgy, extraction and purification methods for metals. Periodicity in properties of the s- and p-block elements which is necessary in understanding their group chemistry. Further, the important properties of 3*d* series transition elements, lanthanoids and actinoids.

Course Learning Outcomes:

After completion of the course students will be able to:

1 Understand the quantum mechanical model,metallurgy, hydrometallurgy, the method of extraction of some important metals and the purification of metals using electrolytic and oxidative refining, van Arkel-de Boer process and Mond's process.
2 Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of *s*- and *p*-block elements.
3 Understand the important properties of transition metals (*3d* series) like variable oxidation states, colour, magnetic and catalytic properties.
4 Understand the important properties of Lanthanoids and Actinoids such as electronic configuration, oxidation states, magnetic and spectral properties.

Unit 1:

Atomic Structure: Recapitulation of Bohr's theory and its limitations, Dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty Principle. Significance of quantum numbers, orbital angular momentum.Shapes of *s, p and d* atomic orbitals, nodal planes.Rules for filling electrons in various orbitals, Electronic Configurations of the atoms.Stability of half-filled and completely filled orbital.Relative energies of atomic orbitals, Anomalous electronic configurations.

(Lectures: 10)

Unit 2:

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds.

(Lectures: 05)

Unit 3:

Covalent Bonding: Valence Bond Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non- bonding combination of orbitals, MO treatment of homo-nuclear diatomic molecules and hetero-nuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

(Lectures: 12)

Unit 4:

General Principles of Metallurgy: Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process**.**

(Lectures: 13)

Unit 5:

***s*- and *p*- Block Elements:** Periodicity in s- and p- block elements, w.r.t. electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity. Inert pair effect, diagonal relationship and anomalous behavior of first member of each group. Concept of multi-centre bonding (diborane).Structure, Applications in industrial, organic and environmental chemistry.Hydrides of nitrogen (NH_3, N_2H_4, N_3H, NH_2OH**).**

(Lectures: 10)

Unit 6:

Transition Elements (*3d* series): General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties.

Lanthanoids and actinoids: Electronic configurations, Oxidation states, colour, magnetic properties, lanthanoid contraction.

(Lectures: 10)

Practical:

(Credits: 02, Laboratory periods: 60)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.
6. Semi-micro qualitative analysis using H_2S of mixtures not more than four ionic species (Two anions and two cations, and excluding insoluble salts) out of the following:
   Cations: NH_4^+, Pb^{2+}, Ag^+, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+.

   Anions: CO_3^{2-}, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, NO_3^- , CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-,SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^- (Spot tests should be carried out wherever feasible.)

References:

Theory:

1. **Concise Inorganic Chemistry**, Lee, J.D., Fifth Ed., Wiley India.India, 2008.
2. **Inorganic Chemistry- Principles of Structure and Reactivity**, Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K., Pearson Education 2009.
3. **Inorganic Chemistry,** Miessler, Gary L., Fischer Paul J., Tarr, Donald A. Fifth Ed., Pearson, 2014.

Practical:

1. **Vogel's Textbook of Quantitative Chemical Analysis**, Jeffery, G.H., Bassett, J., Mendham, J., Denney, R.C., 5th Ed.
2. **Longman Scientific & Technical**, England, (John Wiley and Sons Inc, 605 Third Avenue, New York NY 10158).

Keywords:

Atomic Structure, Quantum Numbers, Electronic configuration, Electronegativity, Ionic Bonding, Covalent Bonding, Hybridization, Atomic orbitals, Molecular Orbitals, Bonding MO, Anti-bonding MO, Metallurgy, Ellingham diagrams, Hydrometallurgy, Electrolytic, Oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Multi-centre bonding, Hydrides, Transition Elements, Lanthanides and actinides, Oxidation states, Magnetic properties and Lanthanide contraction.

CHEMISTRY - C II: ORGANIC CHEMISTRY-I (Core Course Chemistry)

Total Credits: 06 (Credits: Theory-04, Practical-02)
(Total Lectures: Theory- 60, Practical-60)

Objective:

The core course Organic Chemistry I is designed in a manner that it forms a cardinal part of the learning of organic chemistry for the subsequent semesters. The course is infused with the basic concept and the introduction of new concept of visualizing the organic molecules in three dimensional spaces. To establish application of these concepts, the functional groups-hydrocarbons, alkyl and aryl halides are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Course Learning Outcomes:

On the completion of the course the students will become well verse with the basic concepts of organic chemistry and stereochemistry. With the introduction of some functional groups like hydrocarbons, alkyl and aryl halides, the students will be able to understand types of organic reactions and the related concepts. They can think and planthe conversion of one reactant into the other.

Unit 1:

Basic concepts: Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and Electrophiles. Reactive intermediates: Carbocations, Carbanions and Free radicals.

(15 Lectures)

Unit 2:

Aliphatic Hydrocarbons: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: Preparation: Catalytic hydrogenation, Kolbe's synthesis, Grignard reagent; Reactions: Free radical, Substitution, Halogenation.

Alkenes: Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); Reactions: Hydration, Ozonolysis, hydroboration-oxidation.

Alkynes: Preparation: Acetylene from CaC_2 andconversion into higher alkynes, by dehalogenation oftetrahalides; Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$.

(15 Lectures)

Unit 3:

Aromatic hydrocarbons: Concept of Aromaticity, Hukel's rule and other factors.Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation, Friedel-Crafts reaction and sulphonation, (Upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (Upto 4 carbons on benzene), Orientation and reactivity in mono-substituted benzenes.

(10 Lectures)

Unit 4:

Alkyl and Aryl Halides:

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN_1 and SN_2) reactions; Preparation: from alkenes and alcohols; *Reactions:* hydrolysis, nitrite and nitro formation, nitrile and iso-nitrile formation. Williamson's ethersynthesis: Elimination vs Substitution.

Aryl Halides: Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer&Gattermann reactions; Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent.

(10 Lectures)

Unit 5:

Stereochemistry: Conformations w.r.t. ethane, butane and cyclohexane. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and Erythro; D and L; cis – trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

(10 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved in the following preparations to be discussed.
    (a) Bromination of Phenol/Aniline
    (b) Benzoylation of amines/phenols
    (c) Nitration of nitrobenzene
4. Recrystallisation, determination of melting point and calculation of quantitative yields also to be done.
5. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing one extra element).

References:

Theory:

1. **Organic Chemistry**, Morrison,R.T., Boyd, R.N., Second Ed., Allyn and Bacon, Boston, MA, 560, 1966.
2. **A Guide Book to Mechanism in Organic Chemistry**, Peter Sykes, Orient Longman,1986.
3. **Organic Chemistry (Vol. I & II)**, Finar, I. L., E. L. B. S.,1971.
4. **Advanced Organic Chemistry**, Arun Bahl and B. S. Bahl, S. Chand and Co., 1987.

Practical:

1. **Textbook of Practical Organic Chemistry**, Vogel, A.I. Prentice Hall, 5th Ed.
2. **Practical Organic Chemistry**,Mann, F. G., Saunders, B. C, Orient Longman(1960).

Keywords:

Electronic displacements, Alkanes, Alkenes, Alkynes, Aromaticity,Stereochemistry, Nucleophilic substitution.

CHEMISTRY - C III: PHYSICAL CHEMISTRY (Core Course Chemistry)

Total Credits: 06 (Credits: Theory-04, Practical-02)
(Total Lectures: Theory- 60, Practical-60)

Objective:

The aim of this course to make students able to understand thermodynamic concepts, properties of thermodynamic systems, laws of thermodynamics, Basic concepts of Conductance, Electrochemistry, Ionic Equilibria and solutions and their correlation among themselves and other branches of chemistry and also with happenings in nature and life.

Course Learning Outcomes:

Student will be able to apply class room knowledge with local environmental phenomenon and interpret them in relation to chemistry involved in same both conceptual and experimental as well.

Unit 1:

Chemical Thermodynamics: Definition, State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, thermodynamic properties. First Law of thermodynamics. Calculation of work (w), heat (q), changes in internal energy (ΔU) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal conditions for both reversible and irreversible processes. Various statements of Second Law of thermodynamics, concept of entropy, Gibbs free energy and Helmholtz energy, Calculations of entropy change and free energy. Criteria of spontaneity. Gibbs – Helmholtz equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances. Concept of efficiency, Examples of real-time thermodynamics in action e.g. efficient cooking process, refrigeration and preservation of edible items by arresting entropy change.

(15 Lectures)

Unit 2:

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{e}, Le Chatelier's principle.

(8 Lectures)

Unit 3:

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, solubility product, Buffer solutions. Chemistry of Antacids and pH Balance in stomach, Acid/Base properties of water.

(9 Lectures)

Unit 4:

Conductance: Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions. Ionic mobility. Applications of conductance measurements: solubility and solubility products of sparingly soluble salts, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

(10 Lectures)

Unit 5:

Electrochemistry: Types of electrodes. Standard electrode potential.Electrochemical series. Liquid junctionpotential, salt bridge, Nernst equation,pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations - qualitative treatment (acid-base and oxidation-reduction only). Electrochemistry involved in biological systems (CNS), Corrosion etc.

(8 Lectures)

Unit 6:

Solutions: Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations fromRaoult's law – non-ideal solutions. Vapor pressure-composition and temperature-compositioncurves of ideal and

non- ideal solutions. Distillation of solutions. Azeotropes.Partial miscibility of liquids: Critical solution temperature; effect of impurity on partialmiscibility of liquids.Nernstdistribution law and its applications, solvent extraction. Effect of pH on Solubility, pH of Soft drinks and impact on health, examples like Tooth decay etc.

(10 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
3. Determination of enthalpy of hydration of copper sulphate.
4. pH measurements: a. Measurement of pH of different solutions, like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter. b. Preparation of buffer solutions:
    a) Sodium acetate-acetic acid
    b) Ammonium chloride-ammonium hydroxide
5. Surface tension measurement (use of organic solvents excluded):
    a) Determination of the surface tension of a liquid or a dilute solution using a Stalagmometer
    b) Study of the variation of surface tension of a detergent solution with concentration
6. Viscosity measurement (use of organic solvents excluded):
    a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's Viscometer
    b) Study of the variation of viscosity of an aqueous solution with concentration of solute
7. Phase equilibria:
    a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
    b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
    c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

References:

Theory:

1. **Physical Chemistry**, Peter, A., Paula, J. de. Fifth Ed., Oxford University Press, 2011.
2. **Physical Chemistry**, Castellan, G. W. Fourth Ed., Narosa, 2004.
3. Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**,Vol 1, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L.(2015), **A Textbook of Physical Chemistry**, Vol 2, 6th Edition,McGraw Hill Education.

Practical:

1. **Senior Practical Physical Chemistry**, Khosla, B. D., Garg, V. C., Gulati, A., R. Chand & Co.: New Delhi, 2011.
2. **Experimental Physical Chemistry**,Athawale, V. D., Mathur, P., New Age International: New Delhi, 2001.

Keywords:

State and Path functions, Heat, Thermodynamic systems, pH scale, Electrolytic conductance, Electrode potential, Electrochemical Cell, Osmotic pressure, Azeotropes and Critical solution temperature.

CHEMISTRY - C IV: ORGANIC CHEMISTRY-2 (Core Course Chemistry)

Total Credits: 06 (Credits: Theory-04, Practical-02)
(Total Lectures: Theory- 60, Practical-60)

Objective:

The core course Organic Chemistry is designed in a manner that the basic concept and functional group chemistry taught in the previous core course is further augmented by the introduction of more functional groups. Further, the synchronization of chemistry with the biomolecules like carbohydrates and proteins is also focused upon.

Course Learning Outcomes:

On the completion of the course, the students can comfortably perform the following tasks: i. conceptualize the facts related to the functional groups, ii. recognize many types organic reactions, iii. think and plan the conversion of one reactant in to the other and iv. become aware of synchronization of chemistry and biology and hence learn the importance of chemistry in a biological world too.

Unit 1:

Alcohols, Phenols and Ethers (Upto 5 Carbons):

Alcohols: *Preparation:* Preparation of 1°, 2°and 3° alcohols: using Grignard reagent, Ester hydrolysis, Williamson Synthesis; Reduction of aldehydes, ketones, carboxylic acid and esters; Reactions*:* With sodium metal, HX (Lucas test), esterification,

Phenols: (Phenol case) *Preparation:* Cumenehydroperoxide method and from diazonium salts; Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer - Tiemann Reaction, Gattermann-Koch Reaction.

Ethers: Williamson's ether synthesis**.**

(10 Lectures)

Unit 2:

Carbonyl Compounds (Aldehydes and Ketones): Preparation of Acetaldehyde and Acetone; Reactions –Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test.Wittig reaction, Clemensen reduction and Wolff Kishner reduction.Aldol Condensation, Cannizzaro Reaction, Rosenmund Reduction.

(10 Lectures)

Unit 3:

Carboxylic acids and their derivatives:

Carboxylic acids (aliphatic and aromatic): *Preparation:* Acidic and Alkaline hydrolysis of Esters; *Reactions:* Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides; Esters and Amides from acids and their inter-conversion; Reactions: Reformatsky reaction, Perkin condensation.

(10 Lectures)

Unit 4:

Amines and Diazonium Salts:

Amines (Aliphatic and Aromatic): (Upto 5 carbons)Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction; Reactions: Hofmann VsSaytzeff elimination, Carbylamine test.

Diazonium salts: *Preparation:* from aromatic amines. *Reactions:* conversion to benzene, phenol, Sandmeyer Reactions, azo dyes.

(10 Lectures)

Unit 5:

Amino Acids, Peptides and Proteins: Preparation of Amino Acids: Strecker synthesis, using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis; *Reactions of Amino acids*: esterification of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of primary, secondary, tertiary and quaternary Structure of proteins.Determination of primary structure of peptides by degradation Edmann degradation (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme).Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) and C-activating groups and Merrifield solid phase synthesis.

(10 Lectures)

Unit 6:

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers,Mutarotation and Anomers.Determination of configuration of Glucose (Fischer proof).Cyclic structure of glucose.Haworth projections.Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

(10 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. Systematic Qualitative Analysis of Organic Compounds possessing mono-functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1° amines).
2. **Preparation of derivatives:** Mechanism of various reactions involved to be discussed:

   (a) Preparation of carboxylic acid by alkaline hydrolysis of ester/amide.

   (b) Oxidation of alcohol/aldehydes/hydrocarbons to carboxylic acid

   (c) Amides and/or anilides from carboxylic acid.

   (d) Oxime and 2, 4- dinitrophenylhydrazone of aldehyde/ketone

   (e) Osazone from glucose/fructose

   (f) Preparation of methyl orange.

Recrystallization, determination of melting point and calculation of quantitative yields to be done.

References:

Theory:

1. **Organic Chemistry**, Morrison, R.T., Boyd, R.N., Second Ed., Allyn and Bacon, Boston, MA, 560, 1966.
2. **A Guide Book to Mechanism in Organic Chemistry**, Peter Sykes, Orient Longman,1986.
3. **Organic Chemistry (Vol. I & II)**, Finar, I. L., E. L. B. S.1971.
4. **Advanced Organic Chemistry**, Arun Bahl and B. S. Bahl, S. Chand and Co., 1987.

Practical:

1. **Textbook of Practical Organic Chemistry**, Vogel, A.I. Prentice Hall, 5th Ed.
2. **Practical Organic Chemistry**, Mann, F. G., Saunders, B. C, Orient Longman(1960).

Keywords:

Alcohols, Lucas test, Phenols, Williamsons Ether Synthesis, Aldehydes, Ketones, Carboxylic acids, Hell-VohlardZelinsky reactions, Diazonium salts, Proteins, Carbohydrates, Zwitterion, Isoelectric point, Electrophoresis, Reducing and Non reducing sugars.

DISCIPLINE SPECIFIC ELECTIVE - (DSE) CHEMISTRY
DSE-1: SOILS & FERTILIZERS

Total Credits: 06 (Credits: Theory-04, Practical-02)
(Total Lectures: Theory- 60, Practical-60)

Objectives:

Soil is the biologically active as well as porous medium that has developed in the uppermost layer of Earth's crust. Soil is the natural resources for many nutrients which are required during the plant's growth and its development. Fertilizers are applied to the soils as supplementary nutrients and they also contribute to the enhancement of the growth of plants.

Course Learning Outcomes:

Students will able to understand about the different types of soils and fertilizers. They can also learn about the soil composition and its other important physical properties. They may be able to guide farmers/ society, that what type of fertilizer they can add for nourishment of their soils for better crop productivity.

Unit 1:

Soils: Formation, nature, origin, composition, classification. Characteristics, acidity, salinity, alkanity and chemical properties (Cation Exchange Capacity) of soils. Chemistry of weathering of materials, soils and clay minerals.

(15 Lectures)

Unit 2:

Mineral Nutrients: Essential and beneficial elements, macro and micronutrients, methods of study, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

(10 Lectures)

Unit 3:

Types of Fertilizers: Different types of fertilizers (N, P and K) and their soil reactions. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime, potassium Sulfate. Controlled release fertilizers. Environmental aspects of fertilizers.

(25 Lectures)

Unit 4:

Biofertilizers: General account about the microbes used as biofertilizer: Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.
Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and industrial wastes – biocompost making methods, types and method of vermicomposting and its field application.

(10 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. Preparation and preservation of soil sample in laboratory.
2. To measure the pH of some given soil samples.
3. To determine organic carbon from soil sample.
4. To estimate the carbonate content in the given soil samples.
5. Determination of water holding capacity of soil.
6. Estimation of nitrogen in an organic compound (pesticides) by Kjeldahl method.
7. To measure the conductance of some given soil samples.
8. To perform the qualitative test for nitrogen fertilizers (ammonium, nitrate, urea), phosphorus fertilizers (phosphate) and potash fertilizers (potassium).

References:

Theory:

1. **A Practical Book on Soil, Plant, Water and Fertilizer Analysis**, Dubey, S.K.,Arora,A., 2011.
2. **Fertilizers and Their Composition, Characteristics, Quality, Transformations and Applications**, Tandon, H.L.S., 2008.
3. **Fertilizers: Properties, Applications and Effects**, Langdon R., Elsworth, Paley, W.O., Nova Science Pub 2008.
4. **Analytical Agricultural Chemistry**, Chopra, S.L., Kanwar, J.S., Kalyani Publishers, Ludhiana, New Delhi, 1976.

Practical:

1. **Handbook of agriculture** by I. C. A. R. Publication.
2. **Vermiculture and Organic Farming**, Sathe, T.V., Daya publishers, 2004.
3. **Manures and Fertilizers,**Yawalker,K.S.,Agrawal, J.P., Bokde, S., Agri-Horticultural Publishing House, Nagpur (Maharashtra), 1992.

Keywords:

Soils, Alkalinity, Salinity,Fertilizers, Macro and Micro-nutrients.

DISCIPLINE SPECIFIC ELECTIVE - (DSE) CHEMISTRY
DSE-2: HERBICIDES

Total Credits: 06 (Credits: Theory-04, Practical-02)
(Total Lectures: Theory- 60, Practical-60)

Objective:

Herbicide is used for killing unwanted plants. Therefore, herbicides are an important part of modern agricultural production systems and therefore contribute significantly to the economy of agricultural products.

Course Learning Outcomes:

Students will able to learn about the various types of herbicides and their selective mode of action on unwanted plants. Students can hence promote the future use of herbicides as metabolic inhibitors in plant physiological research, as a result both the pesticide and the plant sciences get the advantages.

Unit 1:

Introduction: Herbicide classification, discovery, selectivity of herbicides, absorption and translocation of herbicides, general mode of action of herbicides and detoxification mechanisms of herbicides.

(10 Lectures)

Unit 2:

Synthesis, technical manufacture, mode of action and uses of representative herbicide in the following classes:

(a) Aryl Alkanoic Acids: 2, 4 D, MCPA, dicamba, dichlorobenzil and dalapon.

(b) Aromatic carbamates: barban and asulam.

(c) Triazines: Simazine.

(d) Bipyridiniums, paraquat and glyphosate

(e) Sulfonylurea: Chlorosulfuron

(f) Uracils: Bromacil

(g) Ureas: Monuron and Isoprotureon

(Lectures 30)

Unit 3:

Herbicide resistance: Weed resistance to herbicides and mechanisms of herbicide resistance. Herbicide resistance case study-black grass (*Alopecurus myosuroids* Huds).

(Lectures 10)

Unit 4:

Herbicides developments: Biological control of weeds, Natural products used as herbicides.

(Lectures 10)

Practical:

(Credits: 02, Laboratory periods: 60)

1. To carryout market survey of potent herbicides with details as follows:

a) Name of herbicide

b) Chemical name, class and structure of herbicide

c) Type of formulation available

d) Manufacturer's name

e) Useful information on label of packaging regarding:

i. Toxicity

ii. LD_{50} ("Lethal Dose, 50%")

iii. Side effects

iv. Antidotes

2. Preparation of 2,4D (2,4-Dichlorophenoxyacetic acid) and MCPA (2-methyl-4-chlorophenoxyacetic acid).
3. Analysis of 2,4D (2,4-Dichlorophenoxyacetic acid) and MCPA (2-methyl-4-chlorophenoxyacetic acid).

References:

Theory:

1. **Agrochemicals preparation and mode of action**, Cremlyn, R.J.W.
2. **Herbicides and Plant Physiology**, Andrew, H.C., John, P.H., Reade, John Wiley.
3. **Herbicides: Theory and Applications**, Soloneski, S., Larramendy, M.L.
4. **Chemistry and mode of action of herbicides**,Crafts, A.S., John Wiley.

Practical:

1. **Biochemistry and Physiology of Herbicide Action**,Fedtke, C., Springer-Verlag Berlin Heidelberg, 1982.

Keywords:

Herbicides, LD_{50}, Antidotes, Herbicides resistance and Natural products.

DISCIPLINE SPECIFIC ELECTIVE - (DSE) CHEMISTRY
DSE-3: FUNGICIDES

Total Credits: 06 (Credits: Theory-04, Practical-02)
(Total Lectures: Theory- 60, Practical-60)

Objective:

Fungicides are a class of pesticides used for killing or inhibiting the growth of fungus. They are extensively used in pharmaceutical industries, agriculture, in protection of seeds during storage and preventing the growth of fungi that produce toxins.

Course Learning Outcomes:

Students will able to understand about the various types of fungicides and their selective mode of action on fungal cells. They may be able to identify the plants diseases as well they become more knowledgeable to recommend a treatment strategy for agricultural fields.

Unit 1:

Introduction: Fungicides classification, discovery, selectivity of fungicides, general mode of action of fungicides.

(Lectures 8)

Unit 2:

Synthesis, technical manufacture, mode of action and uses of representative fungicides in the following classes:

Copper and mercury derivatives

Dithiocarbamates: Thiram, Ziram, Nabam

Dinitro phenols: 2, 4-Dinitro o-Cresol (DNOC) Karathane

Quinines: Dichlone

Benzimidazoles: Benomyl

Organophosphorus fungicides: Kitazine

Phenyl amides: Metalaxyl

Triazoles: Propiconazole

Thiophanates: Thiophanates.

(Lectures 32)

Unit 3:

Fumigation: Classification, Role of Fumigants and fumigation application in field.

(Lectures 10)

Unit 4

Miscellaneous Pesticides: Nematicides, Mollusicides and Rodenticides.

(Lectures 10)

Practical:

(Credits: 02, Laboratory periods: 60)

1. To carryout market survey of potent fungicides with details as follows:

   a) Name of fungicides

   b) Chemical name and structure of fungicides

   c) Chemical class of fungicides

   d) Type of formulation available

   e) Manufacturer's name

   f) Useful information on label of packaging regarding

      i. Toxicity

      ii. LD_{50}

      iii. Side effects

      iv. Antidotes

2. Preparation and use of Thiram, Ziram and Nabam.
3. Efficacy of some fungicides on plant growth.
4. To determine the active ingredient contents of some fungicide formulations using BIS specifications.
5. To demonstrate the fumigation technique.

References:

Theory:

1. **Agrochemicals preparation and mode of action**, Cremlyn, R.J.W., CABI, 1991.
2. **Fungicides in Crop Protection,** H. G. Hewitt and R. P. Oliver.,1998.

Practical:

1. **Fungi and fungicides; a practical manual, concerning the fungus diseases of cultivated plants and the means of preventing their ravages**, Moore C.
2. **A Practical Guide to Turfgrass Fungicides,** Richard Latin., American Phyto pathological Society, 2011.

Keywords:

Fungicides, Fumigation techniques,Formulations,Antidotes and LD_{50}

DISCIPLINE SPECIFIC ELECTIVE (DSE)- CHEMISTRY
DSE-4: DISSERTATION
Total Credits: 06

Objective:

The dissertationis designed as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. The key objective of this paper is to introduce the students to concepts in identification of a research problem and developing a hypothesis. The course will enable students to learn how to carry out survey of literature, perform experiments and analyze data. The student will learn how to write a scientific project report and oral presentation of the results.

Course Learning Outcomes:

On completion of the dissertation, the students can comfortably perform the following tasks: i. survey and study of published literature on the assigned topic; ii. formulate a experiments to be tested; iii learn how to collect and read literature related to the experiments; iv design experiments to test that hypothesis; v. learn about ethical issues in conducting research; vi. learn how to examine the obtained data and interpret the results; vii. learn the skill of writing a project report and viii. learn about ethical issues related to publishing, plagiarism and self-plagiarism.

Suggested topics (make dissertation on any one topic):

1. Botanical insecticides as upcoming tools for agricultural productivity.
2. Assessment of farming practices and uses of agrochemicals in India.
3. Enhanced degradation of pesticide wastes in soil: implications for bioremediation of agrochemical exposure sites.
4. Interactions between agricultural chemicals like pesticide (including their persistence) and soil.
5. Impacts of agrochemical pollution on aquatic communities and human health.
6. Impact of agrochemicals on soil and water quality.
7. Farmer perception of the quality and accessibility of agrochemicals in India.
8. Advances in targeted pesticides with environmentally responsive controlled release by nanotechnology.
9. Pesticides and formulation technology used in India.
10. Impact of pesticides and fertilizers on the Environment.
11. Strengthening of eco-friendly strategies of integrated insect, mite and pest management including: biological control, bio-rational pesticides, host plant resistance and judicious use of pesticides.
12. Regulation of pesticide-usage restricted and banned pesticide.

Contents for Dissertation:

1. Identification of research problem.

2. Survey of literature.
3. Formulation of hypothesis, experimental design and methodology.
4. Analysis of data and interpretation of results.
5. Discussion and conclusion.
6. Writing a dissertation.

Keywords:

Botanical insecticide, Agrochemicals, Bioremediation, Environment, Nanotechnology, Fertilizer, Biological control and Bio-rational pesticides

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SKILL-ENHANCEMENT ELECTIVE (SEC) - CHEMISTRY
SEC-1: CONVENTIONAL INSECTICIDES

Total Credits: 04 (Credits: Theory-02, Practical-02)
(Total Lectures: Theory- 30, Practical-60)

Objective:

Conventional insecticides are synthetic chemicals used for quick killing and effective control of insect population. Biopesticides tend to be highly targeted to specific pests while conventional insecticides allow farmers to control numerous pests with one agrochemical only.

Course Learning Outcomes:

Students will be able to learn about the various types of synthetic pesticides available in the market and their selective mode of action on insect population. They can promote the future use of insecticides as metabolic inhibitors in insect physiological research. And as a result both the pesticides and the plant sciences get the boost.

Unit 1:

Carbamate Insecticides: Synthesis, nomenclature, structure activity relationship (SAR), mode of action, benefits and adverse effects of the following carbamate insecticides: Carbaryl, Carbofuran and Methomyl.

(8 Lectures)

Unit 2:

Organophosphorus Insecticides: Synthesis, nomenclature, structure activity relationship (SAR), mode of action, benefits and adverse effects of the following organophosphates: Malathion and Parathion

(10 Lectures)

Unit 3:

Organochlorine Insecticides: Synthesis, nomenclature, structure activity relationship (SAR), mode of action, benefits and adverse effects of the following Organochlorines: DDT, Gammaxene, Chloridane, Hptachlor, Aldrin and Endosulfan.

(12 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. To carryout market survey of potent pesticides (*five or more*) with details as follows:

    a) Name of pesticide

    b) Chemical name, class and structure of pesticides

    c) Type of formulation available and Manufacturer's name

    d) Useful information on label of packaging regarding: Toxicity, LD_{50} ("Lethal Dose, 50%"), Sideeffects and Antidotes.

2. Preparation of simple Organochlorine pesticides.
3. To calculate acidity/alkalinity in a given sample of pesticide formulation as per BIS specifications.
4. To calculate active ingredient in a given sample of pesticide formulation as per BIS specifications.

References:

Theory:

1. **Insecticides in Agriculture and Environment**, Perry, A.S., Yamamoto, I., Shaaya, I., Perry, R., Narora Publishing House.
2. **Carbamate Insecticides, Chemistry,Biochemistry and Toxicology**, Kuhr, R.J.,Derough, H.W., CRC Press.
3. **Insecticide, Action and Metabolism**, O'Brien, R.D., Academic Press, New York and London.
4. **Chemical Pesticides: Mode of Action and Toxicology**, Stenersen, J., CRC, 2004.

Practical:

1. **Agrochemicals preparation and mode of action**, Cremlyn, R.J.W.

Keywords:

Conventional Insecticide, Carbamates, Organophosphorus Compounds and Organochlorine Compounds.

SKILL-ENHANCEMENT ELECTIVE (SEC) - CHEMISTRY
SEC-2: BIOLOGICAL INSECTICIDES

Total Credits: 04 **(Credits: Theory-02, Practical-02)**
(Total Lectures: Theory- 30, Practical-60)

Objective:

The biological insecticides are obtained from natural materials and used to kill or control insect's population. These pesticides are eco-friendly in nature and are also found to be more compatible with the environmental components than the synthetic pesticides.

Course Learning Outcomes:

Students will be able to learn about the various types of biological pesticides used to control pest and also about their selective mode of action. Students can promote the use of biological pesticides in society as they are more environmental friendly.

Unit 1:

Introduction: Definition, uses and adverse effects of biological pesticides; Types of biological pesticides (biochemical pesticides, microbial pesticides and plant-incorporated protectants).

(6 Lectures)

Unit 2:

Chemistry of Microorganisms in Biological Pest Control: Mode of action, advantages and disadvantages of following microorganism in biological pest control: Bacteria (*Bacillus thuringiensis*), Fungi (*Beauveria bassiana*), Protozoa (*Nosema locustae*), Virus (Gypsy moth nuclear plyhedrosis, NPV) and Nematodes (*Steinernema feltiae*).

(12 Lectures)

Unit 3:

Botanical Insecticides in Biological Pest Control: Alkaloids (Nicotine), Pyrethrum (natural & synthetic pyrethroids), Azadirachtin, Rotenone andLimonene.

Botanical insecticides and their mode of action[Nostructure elucidation or synthesis is required for the above compounds]

(10 Lectures)

Unit 4:

New Tools in Biological Pest Control: Repellants, Chemosterilants, Antifeedants, Sex attractants.

(2 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. To carryout market survey of potent botanical pesticides (*five or more*) with details as follows:

a) Botanical name and family; b) Chemical name (active ingredient) and structure of active ingredient; c) Type of formulation available and Manufacturer's name; d) Useful information on label of packaging regarding: Toxicity, LD_{50} ("Lethal Dose, 50%"), Side effects and Antidotes.

2. Identification of common natural enemies of crop pests (parasitoids, predators, microbes).
3. Study the damage caused by the commonly occurring insect pests – Infected plant/plant parts (infected specimen should provide).
4. Preparation of Neem and *Lantana Camara* based botanical pesticides.
5. Field trips to bio-control laboratories – IARI fields, CWC, FCI (*any two*).

References:

Theory:

1. **Microbial Control of Insects and Mites**, Burges, .H.D., Hussey N.W. (Eds). Academic Press, London, 1971.
2. **Biological Control of Insect Pests and Weeds**, De Bach, P., Chapman & Hall, New York, 1964.
3. **Phytochemical Biopesticides**, Koul, O., Dhaliwal, G.S. (eds), Harwood Academic Publishers, Amsterdam.
4. **Entomology and pest management**, Pedigo, L.P. Prentice Hall, N. Delhi, 1996.

Practical:

1. **Natural Products in Plant Pest Management**, Dubey, N.K., 2011.
2. **Integrated Pest Management: Concepts and Approaches**, Dhaliwal, G.S., Arora, R., Kalyani Pub., New Delh, 2001.
3. **Theory and Practices of Biological Control**, Huffaker, C.B., Messenger, P.S., Academic Press, London, 1976.
4. **Agricultural pest of India and South East Asia**, Atwal, A.S. (1993). Kalyani Pub., New Delhi.

Keywords:

Botanical insecticides, Microorganism, Alkaloids, Pyrethrum, Lantana Camara, Azadirachtin, Rotenone, Limonene, Repellants, Chemosterilants, Antifeedants and Sex attractants.

SKILL-ENHANCEMENT ELECTIVE (SEC) - CHEMISTRY
SEC-3: PESTICIDE FORMULATIONS

Total Credits: 04 **(Credits: Theory-02, Practical-02)**
(Total Lectures: Theory- 30, Practical-60)

Objective:

Pesticide formulations are the integral part of pesticide industry. Pure pesticides are highly toxic in nature. As the small amount of pesticides are required for the large cultivated areas, so for the pesticide application it is necessary to formulate the pesticide in a more viable form.

Course Learning Outcomes:

Students will able to learn about the various types of pesticide formulation for commercial use as well as for domestic use. They are also able to demonstrate the comprehension of chemical product use via label and MSDS sheet published.

Unit 1:

Introduction: Definition, purpose of formulations, different types of formulations.

(6 Lectures)

Unit 2:

Characteristics and specifications of formulation: Physio-chemical characteristics of formulations, important BSI specification.

(10 Lectures)

Unit 3:

Formulation of common pesticides: Wettable powders, solutions, emulsifiable concentrates, aerosols, dusts and granules.

(8 Lectures)

Unit 4:

Controlled Release Pesticide Formulations: Polymeric pesticides.

(6 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. To check following physico-chemical parameters for pesticides (*five or more*) using BIS specifications:
    i. Acidity/Alkalinity (for all samples)
    ii. Particle size (for DP/WP/Gr)
    iii. Bulk density (for DP)
    iv. Suspensibility (for WP)
    v. Emulsion stability (for EC)
    vi. Water runoff test Coated and Attrition test (for Gr)
    vii. Flash point (for EC)

2. To study the various informationsources on a given commercially available pesticides sample (*five or more*)through their label and Material Safety Data Sheets (MSDS).
3. Preparation of spray solution of insecticide.

References:

Theory:

1. **Pesticide Formulationsand Application Systems**, Hall, F.R., Berger, P.D., Collins, H.M., (vol. 14), 1995.
2. **Pesticide Formulation and Adjuvant Technology**,Foy,C.L., Pritchard, D.W.,CRC Press, 1996.
3. **Chemistry and technology of agrochemical formulations**, D. Alan Knowles, D.A., Springer, 1998.

Practical:

1. **Pesticide Formulation**, Wade, R., Dekker, M., Inc. New York, 1973.
2. **IS 2570-1980** for Technical; **IS 9372-1980** for Technical concentrate;**IS 8760-1978** for DP;**IS 2865-1978** for EC.

Keywords:

Pesticide Formulations, Controlled Release Formulation, Wettable powders, Solutions, Emulsifiable concentrates, Aerosols, Dusts and Granules.

SKILL-ENHANCEMENT ELECTIVE (SEC) - CHEMISTRY
SEC-4: ANALYTICAL TECHNIQUES INVOLVED IN PESTICIDE ANALYSIS
Total Credits: 04 (Credits: Theory-02, Practical-02)
(Total Lectures: Theory- 30, Practical-60)

Objective:

Analytical chemistry is a special branch of chemistry which deals with analysis of chemical substances of all sorts. The principles of analytical chemistry can also be used to estimate pesticides used in daily life the to ensure the safer handling of the pesticides.

Course Learning Outcomes:

Students will able to learn about the various types of analytical techniques involved in pesticide analysis. They are able to understand separation of mixtures of pesticides by using simple analytical techniques.

Unit 1:

Separation Techniques: Solvent extraction, TLC and paper chromatography

(4 Lectures)

Unit 2:

Ultraviolet (UV) visible absorption spectroscopy: Electromagnetic radiations, electronic transitions , λmax & ε max, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ max of conjugated dienes and α,β – unsaturated carbonyl compounds for simple compounds.Application of Visible and Ultraviolet spectroscopy in organic molecules.

(8 Lectures)

Unit 3:

Infrared (IR) spectroscopy: Infrared radiations and types of molecular vibrations, functional group and Finger print region. IR spectra of alkanes, alkenes and simple alcohols (inter and intra molecular Hydrogen bonding), aldehydes, ketones, carboxylic acids and derivatives (effect of substitution on >C=O stretching absorptions).Application of Infrared spectroscopy in organic molecules.

(8 Lectures)

Unit 4:

Nuclear Magnetic Resonance (NMR) and Mass spectroscopy (MS):

^{1}H NMR spectroscopy: A brief introduction including shielding and deshielding concept, spin-spin coupling and chemical shifts. Applications of NMR in characterization of simple organic molecules.

Mass spectroscopy: Basic principles, ionization methods, applications in characterization of simple organic molecules.

(10 Lectures)

Practical:

(Credits: 02, Laboratory periods: 60)

1. Separation of a mixture of two pesticides by ascending paper chromatography.
2. Separation of a mixture of two pesticides by thin layer chromatography (TLC).
3. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$in a solution of unknown concentration.
4. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} - phenanthroline complex in solution by Job's method.
5. Identification of simple organic compounds containing the monofunctional groups -carboxylic acid, alcohol, phenol, aldehyde and ketone- by IR spectroscopy (Spectra to be provided).

References:

Theory:

1. **Spectrometric identification of OrganicCompounds**, Silverstein, R.M., Basseler, Morril, John Wiley and Sons. N.Y., 1991.
2. **Spectroscopy of Organic Compounds,**Kalsi, P.S., New Age international publishers, New Delhi, 2005.

3. **Colorimetric Methods of Analysis**, Snell, F.D., Snell, C.T., D. Van Nostrand Co.NewYork, 1959.

Practical:

1. **Senior Practical Physical Chemistry**, Khosla, B.D., Garg, V.C., Gulati, A., R.Chand &Co., New Delhi, 2011.
2. **Experiments in Physical Chemistry**, Garland, C.W., Nibler, J.W., Shoemaker, D.P. Eighth Ed., McGraw-Hill, New York, 2003.
3. **Experimental Physical Chemistry**, Halpern, A.M., Mc. Bane, G.C.,Third Ed., W.H. Freeman &Co., New York, 2003.

Keywords:

Ultraviolet- Visible absorption spectroscopy,Infra-Red (IR) spectroscopy, Nuclear Magnetic Resonance spectroscopy, TLC, paper chromatography.

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