

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

DISCIPLINE SPECIFIC ELECTIVE COURSE – 02

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Physical Principles in Agrochemicals	4	2	0	2	-	NIL

Course objectives

The Learning Objectives of this course are as follows:

- explain the laws of thermodynamics and their applications in agrochemical formulation and stability.
- Compute and interpret enthalpy, entropy, and Gibbs free energy changes in agrochemical reactions.
- Principles of catalysis and enzyme kinetics, particularly in the context of bio-pesticide action.
- Role of surfactants and micelles in pesticide formulations and critical micelle concentration (CMC).
- Analyze how pKa and pH affect the ionization and solubility of pesticides in different environmental conditions.
- Correlate lipophilicity with pesticide bioavailability, uptake, and systemic activity in target organisms

Learning outcomes

The Learning Outcomes of this course are as follows:

- Define key physicochemical properties of pesticides (e.g., solubility, volatility, vapor pressure, partition coefficient, and degradation rates).
- Describe the fundamental principles of enzyme kinetics

- Define photochemical transformation and its relevance in the environmental fate of pesticides.
- Explain the mechanisms of direct and indirect photolysis of pesticides under natural and artificial light sources

SYLLABUS OF DSE- 02

THEORY COMPONENT-

UNIT 1:

(7Hours)

Physicochemical Properties of Pesticides:Physicochemical properties (solubility, octanol-water partition coefficient, vapor pressure, soil adsorption coefficient, emulsion stability, half-life, shelf-life etc.) and their testing, Formulation-toxicant interactions.Distribution coefficient of pesticide-its mobility, persistence, and potential to contaminate environment. Significance of studying the physicochemical properties.

UNIT 2:

(7Hours)

Photochemical transformation of pesticides:Introduction to photochemistry, direct and indirect photolysis, photosensitizers, quenchers, light filters, quantum yield. Photo transformation pesticides and their significance. An overview of broken-down Pesticide and health risk of altered transformed products photochemically.

UNIT 3:

(10 Hours)

Enzyme Kinetics and Application in Agrochemical Degradation: Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Enzyme specificity. Active site, Principles of activation energy, transition state. Interaction between enzyme and substrate- Lock and Key Theory. Kinetics of Enzyme Inhibition- irreversible and reversible, types of reversible inhibitions- competitive and non-competitive. Feedback inhibition.

UNIT 4: (6Hours)

Surface and Colloid Chemistry in Agrochemicals: Critical micelle concentration (CMC), Emulsions, suspensions, and colloidal stability. Adsorption isotherms (Langmuir and Freundlich): application in soil-pesticide interaction. Wettability, contact angle, and spreadability on leaf surfaces.

PRACTICAL COMPONENT

(60Hours)

1. To measure the solubility of a pesticide in water at room temperature.
2. To evaluate the lipophilicity of a pesticide by calculating log P using 1-Octanol/Water System.
3. To determine the dissociation constant (pKa) of an agrochemical using UV-Visible Spectroscopy.
4. To study how solubility varies with pH due to ionization of pesticide.
5. Determination of surface tension and contact angle of formulations.
6. Study of adsorption of pesticide on soil using isotherms.
7. Kinetics of pesticide degradation under various pH conditions.
8. To determine the distribution coefficient of a pesticide by studying its adsorption onto soil from an aqueous solution.
9. Writing the assigned an in-depth analysis of at least three pesticides to be allotted by instructor for evaluation of Physical principles by surveying the data from literature.

ESSENTIAL/RECOMMENDED READINGS

1. "Physical Chemistry" – P.W. Atkins
2. "Pesticide Formulation and Adjuvant Technology" – Chester L. Foy
3. "Agrochemical Discovery: Insect, Weed and Fungal Control" – John J. Beck
4. Journal Articles from Pest Management Science, Journal of Agricultural and Food Chemistry
5. K.H. Buchel - "Chemistry of Pesticides" Classic text explaining the chemistry, mode of action, and environmental aspects.
6. K.S. Birdi- "Surface Chemistry"
7. B.D. Khosla -Practical Physical Chemistry
8. S.S. Balpande- Laboratory Manual for Soil and Agrochemical Analysis
9. Fundamentals of Enzymology: Nicholas Price & Lewis Stevens

KEYWORDS: Physicochemical Properties of Pesticides, Formulation-toxicant interactions, Photochemical transformation of pesticides, Kinetics of Enzyme, Kinetics of Enzyme

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.