

**Rs. 20/-**

**NORTH MAHARASHTRA UNIVERSITY,  
JALGAON - 425 001**

**SYLLABUS  
FOR**

**M. Sc. [Pesticides and Agrochemicals]**

(FROM JUNE, 1993)

**Semester I to IV**

**Department of Chemical Sciences**

SEMESTER - I

- PAC-101 INTRODUCTION TO AGROCHEMICALS
- PAC-102 APPLIED CHEMISTRY
- PAC-103 BASIC PRINCIPLES OF CHEMICAL PROCESSES
- PAC-104 COMPUTER PROGRAMMING AND UTILIZATION
- PAC-105 LABORATORY COURSE-I

SEMESTER - II

- PAC-201 PLANT PATHOLOGY AND INSECT MORPHOLOGY
- PAC-202 PESTICIDES SYNTHESIS-I
- PAC-203 ORGANIC REACTIONS AND SYNTHESSES
- PAC-204 INSTRUMENTAL METHODS OF ANALYSIS.
- PAC-205 LABORATORY COURSE-II

SEMESTER - III

- PAC-301 PESTICIDES SYNTHESIS - II
- PAC-302 PRINCIPLES OF PEST CONTROL
- PAC-303 SOLID FERTILIZERS
- PAC-304 PROJECT - I
- PAC-305 LABORATORY COURSE - III

SEMESTER - IV

- PAC-401 PESTICIDE FORMULATION
- PAC-402 FLUID FERTILIZERS
- PAC-403 PLANT GROWTH REGULATORS
- PAC-404 PROJECT - II
- PAC-405 LABORATORY COURSE - IV

M.Sc.[PESTICIDES AND AGROCHEMICALS]

[Two year Course]

FIRST YEAR

SEMESTER - I

Subject codes	Subject	Scheme of Examination		
		Internal	External	Total Marks
PAC-101	INTRODUCTION TO AGROCHEMICALS	40	60	100
PAC-102	APPLIED CHEMISTRY	40	60	100
PAC-103	BASIC PRINCIPLES OF CHEMICAL PROCESSES	40	60	100
PAC-104	COMPUTER PROGRAMMING AND UTILIZATION	40	60	100
PAC-105	LABORATORY COURSE-I	40	60	100
TOTAL		200	300	500

## PAC-101 : INTRODUCTION TO AGROCHEMICALS

1. Definition and general classification of agrochemicals. Classification of pesticides on the basis of chemical nature and according to group of pests. Examples and structures of each type.
2. Introduction and classification of pests. A brief discussion of each type.
3. Methods of pest control - Objective & Discussion of Natural [Climatic, Topographic, Natural Enemies] and Applied [Mechanical/Physical, Cultural, Biological, Legal and Chemical] control.
4. LD50 & LC50 values
5. Major Insect pest of Agricultural Importances - Life cycle, Marks of identification, Nature of damage and control measures. for Pests of Sorghum, Red Cotton Bug, Mango Stem Borer. Ber fruit Borer.
6. Classification of insecticide according to mode of action. A brief Chemistry of Lead Arsenate, Cryolite, BHC, DDT, Thimet, Metasystox, P-dichlorobenzene, Hydrogen Cyanide, Nicotine.
7. Pesticidal Formulations -necessity and types.
8. Fungicides - Definition, classification examples of each type. Characteristics of good fungicides. A brief Chemistry of Dimethoate. Inorganic copper, sulphur and mercury compounds.
9. Herbicides - Definition, Classification, Examples. Physical and Chemical Control of Weeds. A brief Chemistry of 2,4-D, 2,4,5-T.
10. Plant growth regulators - Definition, uses, examples and Chemistry IAA and NAA.

### Recommended Books

1. Insect pest management -David Dent
2. Insect pest and their control - J.W.Evans.
3. Agricultural insect pest of the tropics and their control D.S.Hill
4. Agricultural pests - Biology and control measures - B.M. Deoray and T.B. Nikam.
5. Chemistry of Insecticides and Fungicides - U.S. Shree Ramulu
6. Fungicides in Plant Disease Control - Y.L. Nene, P.N. Thapliyal.
7. Fundamentals of Plant Pest Control - D.A. Roberts
8. Chemistry of Herbicides - U.S. Shree Ramulu.
9. All about weed control - S. Subramanian.
10. Molecular & cell Biochemistry Cell Biology - Smith & Wood.
11. Plant growth regulators - L.G. Nickel.

PAC - 102 APPLIED CHEMISTRY

(1) Water Treatment : Soft water, hard water, methods of softening of hard water, lime-soda, zeolite and ion exchange processes. Calculation of softening reagents. Estimation of hardness of water - EDTA and soap titration method. Characteristics of boiler feed water and boiler troubles.

(2) Fuels : Fuels and their classification, calorific value, types of coal and its analysis, preparation and properties of metallurgical coke, classification origin and refining of petroleum, methods of cracking, synthetic gasoline, purification of gasoline, knocking, octane number, cetane number. Natural gas, coal gas, producer gas water gas. Simple problems based on calorific value and combustion calculations.

(3) Synthetic Fibers : Classification, types of polymerisation, classification of plastics, constituents of plastics. Fabrication of plastics, Engineering properties and uses of plastics. Manufacture, properties and uses of plastics. Manufacture, properties and uses of thermoplastics like polyethylene, polystyrene, and thermosetting resins like urea-formaldehyde, phenol-formaldehyde. Common types of synthetic rubber like neoprene, Thiokol, Silicone, polyurethane. Industrial uses of rubber recovery of waste rubber.

(4) Lubricants : Mechanism of lubrication, classification, properties, testing and selection of lubricants.

(5) Refractories : Definition, Criteria of good refractory, classification, properties, conditions which lead to failure of refractories and testing of refractories, manufacture, properties and uses of common refractories.

(6) Corrosion : Electrochemical corrosion, factors affecting the rate of corrosion, different types of corrosion, Metallic, in-organic and organic coating for corrosion protection.

(7) Environmental Pollution :

- i. Air pollution : Introduction, environmental segments, composition of the atmosphere, atmospheric structure, classification of air pollutant, and their effects, control of air pollution, techniques employed for the control of air pollution.
- ii. Water pollution: Introduction, classification of water pollutants, methods used in waste water treatment.
- iii. Soil pollution : Introduction, causes of soil pollution, control of soil pollution.

Recommended Book

- |                          |   |                                   |
|--------------------------|---|-----------------------------------|
| 1) Engineering Chemistry | - | Jain                              |
| 2) Engineering Chemistry | - | Datta                             |
| 3) Engineering Chemistry | - | Agrawal                           |
| 4) Polymer Chemistry     | - | Gowarikar, Viswanathan & Sreedhar |

PAC-103 BASIC PRINCIPLES OF CHEMICAL PROCESSES

- Importance of Chemical Industry, its Development and Growth.
- Importance of the chemical Industry, New Developments in Chemical Technology, The Quality and production cost of Chemical products,

**Basic Principles of Chemical Technology**

-A Chemical Technological process, Classification of Chemical Technological process, Chemical Equilibrium, Rates of Technological Processes, Method of increasing the process rates, Technological Schemes.

**Reactors types**

-For homogeneous processes, Heterogenous processes in Gas-liquid, liquid -solid, Gas -Solid.

**Introduction to unit processes and unit operations  
S Industrial Processes**

Sulphur Industries - Production of Sulphuric acid  
Nitrogen Industries - Production of Nitric acid, Ammonia, Urea, Ammonium Nitrate.  
Phosphorus Industries - Production of Calcium phosphates  
Cement and lime Industries  
Starch and sugar industries

**Recommended Books**

1. Outline of Chemical Technology- C.E.Dryden Ed. by M.Gopal
2. Chemical Process Industries - R.N.Shreve

## FAC-104 COMPUTER PROGRAMMING AND UTILISATION

1. Logical organization of computer system, introduction to number systems, introduction to computer programming. Algorithms & flow charts, programs development process.
2. Introduction to FORTRAN-77, Character set, data types, expressions, operations, standard functions.
3. Sequential Structures:
  - .Assignment Statement
  - .Input & output statements (list-directed)
  - .STOP Statement
  - .END Statement
4. Selective Structures
  - .GOTO Statements : Assigned GOTO, Computed GOTO.
  - .IF Statements : Logical IF, Block IF, Arithmetic IF.
  - .Nested Block IF structures
  - .Multi - alternative selective structure
5. Repetitive Structures :
  - .IF Loop
  - .DO Loop
  - .Nested DO Loop
6. Subscripted variables : Notation
  - .Arrays
  - .DIMENSION Statement
  - .Input/Output of arrays
  - .PARAMETER Statement
7. Format - Directed Input & Output
  - .Input/Output Statements
  - .FORMAT Statement
  - .Format Specifications
8. Subprograms
  - .Purpose & use
  - .Functions : Library, Statement, Function subprograms
  - .Subroutine : CALL Statement
  - .DATA, SAVE, COMMON Statements.
9. File processing
  - .Opening & closing files
  - .Obtaining information about a file
  - .File input & output
  - .File positioning
10. Additional features.
  - Writing FORTRAN - 77 programs for the following.
  - 1. Finding largest/Smallest of given number using array & without array.

2. For arranging given numbers in Ascending/Descending order using array without array.
3. Matrix Multiplication
4. To find Transpose of a given Matrix
5. Find  $\sin x$  using Taylor's series & compare the obtained value with the value obtained using standard function.
6. To accept any inter number & write it in reverse order. Also find sum of its digits.
7. Generate first 100 prime number starting from any prime no.
8. Find GCD of given numbers.

#### Recommended Books

1. V. Rajaraman, Computer programming in FORTRAN-77, PHI (1990).
2. Programming with FORTRAN-77, Ram Kumar, THM

#### Reference

1. Davice & Hoffma FORTRAN-77 : A structured  
Disciplined style  
Mc Graw Hill
2. Kernighan B.W. & Plughter P.J. : Elements of programming  
style  
Mc Graw Hill, New York



PAC-105 LABORATORY COURSE - I

List of Experiments for 1st Semester

PART A

1. Kinetics (Volumetric and colourimetry).
2. Saponification value.
3. Refractometry
4. Determination of C.O.D.
5. Ore Analysis
6. Iodine Value
7. Complex preparation
8. Spectrophotometry

PART B

1. Conductometric titration of mixture of acids
2. Column chromatography
3. pH metric titrations.
4. Experiments on Potentiometry
5. Separation techniques
6. Flame photometry

PART C : LIST OF EXPERIMENTS FOR COMPUTER PROGRAMMING

1. Finding Largest/Smallest of given numbers using array & without array.
2. Arranging numbers in ascending & descending order using array & without array.
3. Matrix Multiplication
4. To find Transpose of a given matrix
5. Find  $\sin(x)$  using Taylor Series Expansion & Compare the obtained value with the value obtained using standard function.
6. To accept any integer number & write it in reverse order. Also find sum of its digits.
7. Generate first 100 prime numbers starting from any prime number.
8. Find GCD of given numbers.

M.Sc. [PESTICIDES AND AGROCHEMICALS]

[Two year Course]

SEMESTER - II

Subject codes	Subject	Scheme of Examination		
		Internal	External	Total Marks
PAC-201	PLANT PATHOLOGY AND INSECT MORPHOLOGY	40	60	100
PAC-202	PESTICIDES SYNTHESIS-I	40	60	100
PAC-203	ORGANIC REACTIONS AND SYNTHESSES	40	60	100
PAC-204	INSTRUMENTAL METHODS OF ANALYSIS.	40	60	100
PAC-205	LABORATORY COURSE-II	40	60	100
TOTAL		200	300	500

In the summer vacation students should undergo industrial training and submit a report.

## PAC-201 PLANT PATHOLOGY AND INSET MORPHOLOGY

1. Fungi - their morphology and reproduction
2. Diseases in plants, Fungal, Bacterial, Viral and Nematodal
3. Symptoms of plant diseases
4. Epidemeology
5. Mechanism of Infection, Indoculum, Incubation, Diseases development (pathogenesis ) & outbreak of pathogen.
6. Casual organisms, symptoms of infection and general control measures of the following plant diseases.
  - a) Powdery mildew of grapes
  - b) Grian smut of Jowar
  - c) Wheat Rust
  - d) Citrus Canker
  - e) Papaya Mosaic
  - f) Tikka disease of Ground nut
  - g) Nematodal diseases
7. Disease control through chemicals
  - a) Characters of good antipathogenic chemicals
  - b) Chemicals used in plant disease control, Sulphur fungicides (inorganic), Sulphur fungicides (Organic), Copper fungicides, Quinones, Benzene compounds, Heterocyclic nitrogen compounds, Antibiotics
8. Methods of application of antipathogenic chemicals  
Spraying, Dusting, seed treatment and  
Soil treatment (physical and chemical)
9. Methods of studying plant diseases
  - a) Visit to diseased field - crops
  - b) Further study in laboratory culturing (PDA medium)  
Isolation of plant pathogen purification of culture
  - c) Equipment essential for the study of diseased crops in field.

### Recommdoned Books

1. Fungi & Plant Diseases by E.B. Mundkur (Mac Millan)
2. Fungi by Rai and Sharma (Kitab Mahal, Allahabad)
3. An introduction to Mycology by D.S. Chahal (Oxford & IBH)
4. Plant diseases by R.S. Singh. (IBH)
5. Plant Diseases by Mathur R.S. (National Book Trust New Delhi)
6. Fungicides in plant disease control Y.L. Nene, P.N. Thapliyal.

### INSECT MORPHOLOGY

1. Crustation - BVS, Respiratory, nervous system, Cell wall structure .. (Skeleton System)
2. Major tropical crop pests - (descriptions, biology & control orthoptera, Isoptera, Homoptera, Heteroptera, Theysanoptera, Lepidoptera, Diptera Hymenoptera, coleopteron Acarina.

### Recommdoned Books

1. Agricultural insect pests of the tropics and their control D.S. Nill, Cambridge Univ. Press.
2. Insect Pest Management David Dent CAB International.
3. Insect Pest & Their Control J.W. Evans.
4. Handbook of Pest Management in Agriculture.

Chemistry and Synthesis of some pesticides . .

1. Insecticide :

Cypermethrin, D.D.T., Decamethrin, Dimethoate, Endosulfon, Endrin, Fenvalerate, Lindane, Malthion, Monocrotophos, Phorate, Ethylene Oxide, Methoxychlor, Parathion, Calcium arsenate, HCN.

2. Rodenticides :

Antu, Bromodiolone, Caphechlor, Coumafuryl, Phosphine, Barium Carbonate, Sodium cyanide, Coumachlor, Zine Phosphide, Wasfarin.

3. Nematicide :

Alicarb, Chloropicrin, Diazinon, Dichlorofanthion, Endoprophos, Oxamyl, Turbufos, Thionazin, D.D.Mix, DBCP, Ethylenedibromide.

4. Soil Fumigants :

Aluminium phosphite, Calcium cyanide, D.D.Mix, DBCP, EDCT mix, Ethylenedibromide, Methyl bromide, paradichlorobenzene.

5. Repellents :

Anthraquinone, chloranil, DEET, Dimethyl phthalate, Ziram.

Recommended Books

1. Chemistry of Insecticides and Fungicides - U.S. Shree Ramulu
2. Pesticide Synthesis- P.S.Marg, G.K.Kohn, J.J.Menn
3. Chemical Weekly's Agrochemicals Dictionary
4. Handbook of Systemic Fungicides Vol- I,II,III - S.C.Vyas
5. Analytical Methods for Pesticides, Plant growth regulators & food additives. Vol., I-IV Ed. By Gunter Zweig.
6. The Agrochemical Handbook - Royal Society, England
7. Pesticide Science and Biotechnology - R. Greenhalgh and T.R.Roberts
8. Outlines of Chemical Technology - C.E.Dryden, Ed. by M.Gopal

## PAC-203 ORGANIC REACTIONS AND SYNTHESIS.

Aromaticity: Huckel's rule and concept of aromaticity; (n) annulenes and heteroannulenes; fullerenes (C<sub>60</sub>).

Stereochemistry and conformational Analysis: Newer methods of asymmetric synthesis (including enzymatic and catalytic nexus), enantio and diastereo selective synthesis. Effects of conformation on reactivity in acyclic compounds and cyclohexanes.

Selective Organic Name Reactions. Feavorskii reaction. Stock enamine reaction. Michael addition. Mannich reaction. Sharpless asymmetric epoxidation. Ene reaction, Barton reaction. Hofmann-Löffler-Freytag reaction, Shapiro reaction, Bayer-Villiger reaction, Chichibabin reaction.

Mechanisms of Organic Reactions; Labelling and kinetic isotope effects, Hammett equation (sigma-rho) relationship, non-classical carbonium ions, neighbouring group participation.

Pericyclic Reactions; Selection rules and stereochemistry of electrocyclic reactions, cycloaddition and sigmatropic shift; Sommelet, Hauser, Cope and Claisen rearrangements.

Heterocycles; Synthesis and reactivity of furan, thiophene pyrrole; pyridine, quinoline, isoquinoline and indole; Skraup synthesis, Fischer indole synthesis.

Reagents in Organic Synthesis. Use of following reagents in organic synthesis and functional group transformation. Complex metal hydrides, Gilman's reagent, lithium dimethylcuprate, lithium diisopropylamide, (LDA), dicyclohexylcarbodiimide, 1,3-dithiane (reactivity umpolung), trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and Prevost hydroxylation, osmium tetroxide, DDQ, selenium dioxide phase transfer catalysis, crown ethers and Merrifield resin. Peterson's synthesis, Wilkinson's catalyst; Baker yeast.

Chemistry of Natural Products; Familiarity with methods of structure elucidation and biosynthesis of alkaloids, terpenoids, steroids, carbohydrates and proteins. Conformations of proteins and nucleic acids.

### Recommended Books

1. Organic Chemistry : Morrison & Boyd Allyn
2. Principle of Organic Synthesis - R.O.C. Norman,
3. Some Modern Methods of Organic Synthesis - W.Carruthers

PAC 204 Instrumental Methods of Analysis :

- 1) Chromatography - Fundamentals and types of chromatography classification : liquid partition chromatography, paper, thinlayer & reversed phase partition chromatography, chemical constitution and Rf value, adsorption chromatography, gas-liquid, column efficiency & resolution, various types of detectors, gel permeation & ion exclusion technique, Ion exchange chromatography, HPLC.
- 2) IR Spectroscopy - Molecular vibrations, Factor influencing vibrational frequencies, Instrumentation, IR sources, Optical system, detectors process analysis, sampling techniques. Interpretation of spectra : - Quantitative analysis, ATR & MIR reflectance, FTIR spectroscopy.
- 3) UV & Visible spectroscopy - Theory of electronic spectroscopy, Instrumentation & Sampling applications, Visual spectroscopy, Visual colorimetry, Photometric filter photometry, spectrophotometry, Simultaneous spectrophotometry, Differential spectrophotometry, Photometric titrations.
- 4) NMR Spectroscopy - Photon NMR Spectroscopy, The NMR phenomenon, Theory of NMR, Chemical shifts and its measurement factors influencing chemical shifts, Sample handling & Instrumentation, Solvent used in NMR, Spin spin coupling, splitting, multiplicity, Applications.
- 5) Mass Spectrometry - Principle, theory, Instrumentation and applications.
- 6) Flame photometry : - Principle, different burners used, events in flame, application, interferences, Factor influencing intensity of emitted radiation limitations of flame photometry.

Recommended Books

- 1) Basic concepts in analytical chemistry - S.M.Khopkar.
- 2) Application of absorption spectroscopy of organic compounds-John R.Dyer
- 3) Physical Biochemistry - Friefeldor
- 4) Organic Spectroscopy - William Kemp
- 5) Analytical Biochemistry- D. Holme & H.Peck
- 6) Instrumental Methods of Chemical Analysis - Willard, Merit, Dean
- 7) Instrumental Methods of Analysis - Chatwal & Anand
- 8) Absorption spectroscopy of Organic Molecules - V.M. Parikh.
- 9) Spectroscopic Methods in Organic Chemistry - D.H. Williams and I Fleming.

PAC-205 Laboratory Course - II

A.

1. Viscosity measurement and its relationship with molecular weight of polymers.
2. End Group analysis
3. Viscosity by Brookfield Viscometer
4. Flash point by Pensky Marken's apparatus
5. Flash point by Abel's Apparatus
6. Synthesis of Novolak resin.
7. Synthesis of polyethylene terphthalate
8. Determination of B.O.D.
9. Relative surface tension of solvents.
10. Moisture content
11. Analysis of Pesticides
12. Bulk Density

B) Instrumental methods.

1. Gas chromatography
2. I.R.
3. N.M.R.
4. Flame Photometry
5. Polarography.

PAC 301 PESTICIDES SYNTHESIS-II

Chemistry & synthesis of some pesticides.

1. Insecticides

Aldrin, azinphos ethyl, azinphos - methyl, B.H.C., BPMC, carbaryl, Carbophenothion, Chinomethonat, Chlorfenvinphos, diazinon, EPN, ethion, ethylene dibromide, methy bromide, formothion, quinalphos.

2. Fungicides -

Benomyl, captan, carbendazim, carb xim, chinomethonat, copper oxychloride, copper sulphate, d folatam, dithianon, epiphenphos, ferbam, MEMC, mancozeb, PCNB, phenyl mercury acetate, thiram, zineb, ziram, fenaminosulf, glyodin.

3. Acaricides.

Benomyl, Chinomethionat, dinocap, carbophenothion, quinalphos, chlorfenvinphos, dimethoate, endosulfan, EPN, formothian, monocrotophos, mevinphos, binapacryl, phenthoate, phosalone, tetradifon, thiodemeton.

4. Herbicides.

Calcium arsenate, dimethachlor, alachlor, Ammonium sulphonate, atrazine, butachlor, 2,4-D, dalapon, dicamba, diuron, fluchloralin, MCPA, MSMA, nitrofen, PMA, pendimethalin, propanil, simazine, triallate, trichloroacetic acid.

5. Other Miscellaneous pesticides.

Molluscicides (fentin acetate, metaldehyde), algicides (fentin acetate), aphicides (menazon, vam dothion), bactericides (streptocycline), weedicide (2,4,5-T), miticide (vamidothion).

Recommended Books

1. Chemistry of Insecticides and Fungicides - U.S.Shree Ramulu
2. Pesticide Synthesis- P.S.Marg, G.K.Kohn, J.J.Menn
3. Chemical Weekly's Agrochemicals Dictionary
4. Handbook of Systemic Fungicides Vol- I,II,III - S.C.Vyas
5. Analytical Methods for Pesticides, Plant growth regulators & food additives. Vol., I-IV Ed. By Gunter Zweig.
6. The Agrochemical Handbook - Royal Society, England
7. Pesticide Science and Biotechnology R. Greenhalgh and T.R.Roberts
8. Outlines of Chemical Technology - C.V.Dryden, Ed. by M.Gopal



PAC-302 PRINCIPLES OF PEST CONTROL

1. Agriculture : Meaning, Importance, Role, Scope, Crop production.
2. Inputs in Agriculture: Different inputs, Listing, Importance
3. Crop Plants Structure : Classification and nomenclature, Structure of Crop plants, Organs of seed plants, Plant body, Life cycle of seed plants.
4. Functions of Crop Plants : Important functions : Growth, Absorption, Translocation, Digestion, Respiration, Transpiration, Photosynthesis, Conducting, Storage of food.
5. Insect Pests : Definition, Meaning- wider, narrower, specific, Types, Classification, Damage, Crop losses due to plant pests - weeds, bacteria, molluscs, fungi, virus, birds, mites, nematodes, insects, vermins, arthropods, plant pathogens, Causes of outbreaks of pests, Growth and development of insects, Entomology - Definition, components, Insect pest control - Introduction, principles, Outlines.
6. Pesticides: Meaning, Classification - methods, principles, Role in agriculture, Types, Methods, Methods of control (Classification) - Natural, Applied
  - i. Physical & Mechanical - exclusion, eradication, therapy, protection, avoidance.
  - ii. Environmental iii. Cultural (Managerial) iv. Biological
  - v. Chemical vi. Legal vii. Autocidal
  - viii. Resistant variety. ix. IPM.
7. Individual Control Measures - 1 to 4,5 and 6 to 8 Description, Outlines, Application, Action/Reaction, Use (Utility).
8. Insecticides : Inorganic, Organic Definition of each type, role, importance, advantages/disadvantages. Types - Herbicides, Fungicides, Insecticides, Rodenticides, Avicides, Acaricides, Nematicides, Bactericides. Insecticides - groups of pesticides, sub-class, mode of action.
9. Herbicides/Weedicides Weeds : Definition, Characteristics, Effects, Usefulness, Classification, Losses, Classification to reduce weed population - prevention, eradication, Methods/Procedure of weed control - Physical, Cultural, Biological, Mechanical Chemical - Selective : Foliage, Soil, Aquatic, Contact, Translocated, Non selective. Methods of Herbicide application - Pre-sowing, Pre-emergence, Post, Post-emergence, Direct, Band Mode of action, Formulations, Herbicidal residue, Precautions, Integrated weed control, Special weeds(Parasites) Herbicides used in India, List of firms, Weed Control measures of important crops.

10. Plant Diseases

Definition, Concepts, Classification of diseases - base/basis, Symptoms, Plant part, Plants, Occurance, Spread, Cause, Disorders, Impact of modern agriculture plant diseases, Dignosis, Principles of plant disease control, Chemicals for Plant Disease Control.

11. Nematicides (Nematology)

12. Insecticides Act

13. Safety Precautions

14. Industry : Role, Shape, Names, Details.

**Recommended Books**

1. Insect pest management -David Dent
2. Insect pest and their control - J.W.Evans.
3. Chemicals for Crop improvement and pest management
4. Insect pest of Farm, Garden and Orchard - R.H. Davidson and Late L.M. Peirs.
5. Agricultural insect pest of the tropics and their control  
D.S.Hill
6. Chemistry of Insecticides and Fungicides - U.S. Shree Ramulu
7. Chemistry of Herbicides - U.S. Shree Ramulu.
8. All about weed control - S. Subramanian.

PAC-303 SOLID FERTILIZERS

1. Essential plant Nutrients and their sources: criteria of essentiality, Forms in which they occur in soil and utilized by plants. functions of plant nutrients.
2. Manures and biological Fertilizers : Classifications, Composting, Farm Yard Manure, Green Manure and Biological Fertilizers.
3. Synthesis Fertilizers : Classification, Nutrients in fertilizers,  
Nitrogenous fertilizers - Manufacture and use  
Phosphatic fertilizers - Manufacture and use  
Potash fertilizers - Manufacture and use  
Complex/compounds fertilizers - Manufacture and use  
Mixed fertilizers - Manufacture and use  
Methods of preparing fertilizer mixture, Formulation of Fertilizer mixture.
4. Fertilizer applications: Time of manuring, methods of fertilizer application.
5. Tips of getting best efficiency of applied fertilizers, calculation of amount of fertilizer.
6. Soil Amendment -pH of soil and plant growth, saline and alkali soils and plant growth.
7. Management of soil fertility - Soil fertility, factors affecting and maintenance.

Recommended Books

1. Manures and Fertilizers - P.C. Das
2. Commercial Fertilizers - Gilbert H. Collings
3. Fertiliser Hand Book Technology - Anonymous (CRC)
4. Fertiliser Hand Book Usage - Anonymous (CRC)
5. Hand Book Manures and Fertiliser - Anonymous (CRC)
6. Chemistry of Fertiliser and Manures - Mariakhland
7. Fertiliser and Manures Their Manufacture, composition and uses - Vaston Earness.
8. Biofertilizers - L.L. Somani S.C. Bhandari, S.N. Saxena, K.K. Vyas.
9. Methods of Analysis of Soil, Plants, Waters & Fertilizers - H.L.S. Tandon.
10. Fertilizers Organic manures recyclable Wastes & Biofertilizers - H.L.S. Tandon
11. Secondary & Micronutrients in agriculture - H.L.S. Tandon.
12. Dictionary of Soil Fertility, Fertilizer & Integrated nutrient Management - H.L.S. Tandon.

**PAC-304 PROJECT - I**

1. Literature survey, data collection, visit to related institutes & industries.
2. Actual Experimental work on assigned problems
3. Analysis, Characterization and results.
4. Dissertation and Viva-Voce.

The work of project - I (3 & 4) is continued in Project - II.

**PAC-305 LABORATORY COURSE-III**

1. Acidity and alkalinity tests & determination.
2. Moisture content tests and determination.
3. Bulk density determination
4. Cold tests.
5. Emulsion stability tests
6. Heat stability tests
7. Analysis of insecticides and fungicides (Titrimetry, Colorimetry, pH metry, polarography, Conductometry)
8. Preparation of pesticides, derivatives and related moieties.
9. Analysis of Fertilizers.

SEMESTER - IV

Subject codes	Subject	Scheme of Examination		
		Internal	External	Total Marks
PAC-401	PESTICIDE FORMULATION	40	60	100
PAC-402	FLUID FERTILIZERS	40	60	100
PAC-403	PLANT GROWTH REGULATORS	40	60	100
PAC-404	PROJECT - II	40	60	100
PAC-405	LABORATORY COURSE - IV	40	60	100
TOTAL		200	300	500

## SEMESTER - IV

### PAC-401 PESTICIDE FORMULATION

1. Formulation - brief account & types, for spray application, wetting agents & additives, wettable & flowable powders.
2. Chemical & physical stabilities & performances, packing, emulsi-fiable oils & performances, solubility limitations, stock emulsions, solution concentrates.
3. Chemical formulations, corrosion, dust aerosol & other automatic dispensers, smoke generators, granules, baits.
4. Use proplems, examples of each formulation type & activities.
5. Plant and animal extracts as pesticides.
6. Purpose of formulation. Adjuncts used in formulation.
7. Use of Computers in the development of pesticide formulation correlation analysis in formulation development and optimization in emulsion formulation.
8. Controlled release formulation, Analysis of pesticide formulation (methods of collaborative testing).
9. Safety of pesticides - safety to wildlife, consumers, farm workers, industrial workers, in transport and distribution in third world, responsibility of manufaturer and farmers to the public.

### Recomnoded Books

1. Chemistry of Pesticides - N.N. Melnikov
2. Chemistry of Pesticides - K.H. Buchel.
3. Advnaces iin Pesticide Formulation Technology - H.B. Scher,
4. Pesticide Chemistry Vol. IV. - J.M. Miyamoto & P.C. Kearney.
5. Pesticide Formulation - W. Valkenburg
6. pesticide Formulation Inovation and development Ed. By. - Barrigton Cron & Herbert B. Scher ACs Symposium Series 371.
7. Emulsifiers and wetting agents - Michale & Irene Ash.
8. Pesticidal Formulations and Agrobased Chemical Food and Paper Products - R.K. Goel & F.K. Gupta.
9. Controlled release pesticide Formulations - N.F. Cardarelli.
10. Pesticide Application methods - G.A. Matthews.
11. Agrobased Industries & Pesticide Formulations - S.B. Strivastva & V.K. Agrawal.

## PAC-402 FLUID FERTILIZERS

1. History and status of fluid fertilizers.
2. Manufacture of nitrogenous, & mixed fluids.
3. Physical and chemical properties, stability and flow properties, sequestration and chelation.
4. Storage and transport problems
5. Applications - drip irrigation, localised culture Application equipments.
6. Agronomic characteristics, Quality and Management, Health, Safety and environmental aspects of fluids.

### Recommended Books

1. Fluid Fertilizers - Ed. D.A. Falgrave
2. Manures and Fertilizers - P.C. Das.
3. Commercial Fertilizer - G.H. Collings.

## PAC-403 PLANT GROWTH REGULATORS

1. Plant growth modification - breeding and propagation, retardation of vegetative growth, control of fruit, defoliation and desiccation, improvement in photosynthesis efficiency, improvement of crop yields, prevention of flowering.

2. Chemistry and synthesis of some PGR.

Ancymidol, carbaryl, chlorflurecol - methyl, chlormequat chloride, chlorpropham, daminozide, dikegulac - sodium, ethephon, indoylacetic acid, indoyl butyric acid, mefluidide, mepiquat chloride, 1-naphthyl acetic acid, piproctanyl bromide, tecnazene, Gibberelic acid. (phytochrome, Ethylene, Auxin, Gibberelins, Cytokinins).

3. Introduction and Brief Chemistry of Growth retardants.
4. Introduction, Classification and brief chemistry of Herbicides.

### Recommended Books

1. Principles and procedures of plant protection - Chattopadhyay.
2. Chemistry weekly's - Agrochemical Dictionary
3. Agrochemical handbook - Royal Society.
4. Handbook of Pest Management in Agriculture Vol. I, II - D. Pimentel.
5. Control mechanisms in Plant Developments - A.W. Galston, P.J. Davies.
6. Chemistry of Herbicides - U.S. Shree Ramulu.

PAC-404 PROJECT - II

The work of project - I (3 & 4) is continued and completed in Project - II.

PAC-405 LABORATORY COURSE - IV

1. Synthesis of PGR and Some derivatives (2)
2. Analysis of PGR (2)
3. Herbicides, Synthesis and Analysis (4)
4. Formulations and their analysis (8)
5. Activity testings and spectrophotometric studies of synthesized pesticides and their derivatives (4)

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