PG Courses: M. Sc. (Ag)		
1st Semester	Theory	Practical
AC 501: Introduction to agrochemicals (2 + 0)	**UNIT I:** Definition, IUPAC approved terminology, statistics of production and consumption. Classification of Plant protection chemicals - an overview; Insecticides Act. **UNIT II:** History of botanical insecticides, structure, properties, mode of action and uses of conventional insecticides such as nicotine, pyrethrins and rotenones. Insect antifeedants and growth regulators including sesquiterpenoids and limonoids, hormone analogues (JH, anti-JH, JH-mimics, moulting hormones), Semiochemicals - pheromones and allelochemicals. UNIT III: Structure, properties, mode of action and uses of synthetics: Insecticides- chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids and others (ex neo-nicotinoids). Fungicides - inorganic, organic- heterocyclic, formamide, alkane, alkane carboxylic acid and miscellaneous groups. Strobilurin fungicides and antibiotics. Nematicides - aliphatic halogen compounds, methyl isocyanate liberators, organophosphates and carbamates. UNIT IV: Formulation of pesticides - definition, classification, objectives, process, product development. Formulation codes, conventional formulations such as EC, WP, Dust, Granule etc. Pesticide adjuvants: synergists. UNIT V: Pesticide residue: Concept definition, significance and analysis as per BIS specifications, Agrochemicals in water, soil, air and non-target organisms- status, impact, monitoring, etc.	
AC 502: Plant Chemistry- I (2 + 1)	Chemistry of Carbohydrates: mono-, di- and polysaccharides; Ring structure determination; Chemistry of some important secondary plant metabolites and plant pigments: Alkaloids, flavonoids, cumarines, carotenoids, chlorophyll. Chemistry of Terpenoids: mono, sesqui-, di- & tri-terpenoids; Brief biogenesis of	Isolation & characterization of some Natural Products: a) Terpenoids, b) flavonoids, c) alkaloids; Estimation of Carotenoids, Chlorophyll from natural products.

	natural products: alkaloid, terpenoid, flavonoids; Isolation, estimation and characterization of terpenoids, alkaloids, flavonoids; carotenoids, chlorophyll and other secondary plant products. Chemistry of antioxidants; Biological significance of secondary plant metabolites.	
AC 503: Basic chemistry-I (2 + 1)	UNIT I: Stereochemistry: Isomers, chiral molecules, optical isomerism. Symmetry elements, asymmetry, chirality a combined look conventions describing configurations D-L and R-S system. Stereoisomerism resulting from more than one centre (diastereoisomers). Geometrical isomerism, E-Z system of nomenclature. Conformations of acyclic and cyclic systems with special emphasis of cyclohexane – forces responsible, Baeyer and Pitzer Strain. UNIT II: Nature of chemical bonding, modern concept of acid-base, mechanisms of some organic reactions, Michaelis-Arbusov, Perkow, Diel-Alder, Aldol Condensation, Rearrangement reaction, etc. Theories of aromaticity, substitution in benzene ring, orientation for further substitution. UNIT III: Nomenclature, preparation, properties and uses of alicyclic compounds. Preparation, properties and uses of substituted aromatic compounds (halogenated, nitro, amino-compounds, diazonium salts, aromatic sulphonic acids, phenols, quinones and aromatic acids). Bicyclic-naphthalene and naphthaquinone. UNIT IV: Heterocyclic chemistry: Nomenclature of furan, thiophene, pyrrole, indole, pyrazole, midazole, oxazole, thiazole, pyridine, piperidine, quinnoline, isoquinnoline, pyran, pyrone, diazine etc. Introduction to natural products: Chemistry of terpenoids, alkaloids, flavonoids and dyes.	Preparation of some organic compounds: Aspirin, Iodoform, p-nitroacetanilide and some related compounds; Separation and identification of organic compounds in binary mixtures.
AC 504: Chemical laboratory techniques (1 + 2)	UNIT I: Laboratory hygiene and safety, laboratory accidents and their management. Human safety and protection, handling and storage of flammable, volatile, health	Introduction to Laboratory equipment and cleaning of glassware, Assembling of simple apparatus, Purification of

	hazardous and corrosive chemicals, glassware safety, emergency response. Precautions and safety while carrying out reactions and handling reaction wastes. UNIT II: Different types of glassware and their use. Laboratory notebook upkeep, maintenance and importance. Melting and boiling points, their determination, apparatus used and allied information. Distillation, fractional distillation, crystallization. Vacuum filtration. UNIT III: Purification and drying of solvents. Solvent removal by distillation, evaporation, reduced pressure evaporation and rotary evaporation (Buchi type). Vacuum pumps, water aspirators etc. and their use. UNIT IV: Steam distillation, supercritical fluid extraction, extraction of volatiles by Clevenger apparatus and solid phase extraction. UNIT V: Chromatography - principle and practice, types etc. Partition and adsorption chromatography with examples (TLC, Paper). Spot visualization, chromogenic reagents, etc.Column chromatography.	solvents, Crystallization, identification by melting point, sublimation, Extraction, Chromatography: Paper, Column, TLC, Preparative TLC, Steam Distillation, Use of stirrer, pump and presentations.

505: Synthetic agrochemicals for insect and mite management (2 + 1)	UNIT I: Introduction and classification of synthetic insecticides, chemistry of conventional organochlorine insecticides: DDT, HCH, Lindane, uses, mode of action and present status, cyclodiene insecticides. : Nomenclature, uses, synthesis and mode of action of aldrin, dieldrin and endosulfan, chemistry of carbamate insecticides: Classification, mode of action, structure activity relation, synthesis and uses of carbofuran, carbaryl, aldicarb and propaxur. UNIT II: Organophosphorus insecticides: Chemistry, classification, mode of action. Important reactions namely Michaelis-Arbuzov reaction, Perkow reaction. Preparation, properties and uses of edifenphos, fenthion, DDVP, monocrotophos, phosphamidon, chlorfenvinfos, malathion, methyl and ethyl parathion. fenitrothion, quinalphos, triazophos, diazinon, chlorpyrifos, phorate, dimethoate, ethion, methamidophos, acephate, azinphosmethyl. UNIT III: Synthetic pyrethroids: Chemistry, classification, mode of action, structure activity relationship, history and evolution from natural pyrethrins. Preparation, synthesis, uses and properties of cypermethrin, deltamethrin, fenvalerate, cyfluthrin, cyhalothrin. UNIT IV: Neonicotinoids: Chemistry, classification, mode of action and uses. Preparation, properties and uses of imidacloprid, acetamiprid, thiomethoxam, thiocloprid. UNIT V: Synthesis insect growth regulators: juvenile hormones and juvenile hormone mimics, anti-juvenile hormone. General introduction and mode of action of ecdysones and ecdysoids. Inhibitors of chitin synthesis. Chemosterilants, alkylating agents, pheromones. UNIT VI: Acaricides: Chemistry, classification, mode of action etc. Properties: 2, 4-dinitrophenols and esters, benzoic acid esters, dicofol, spiromeisifen.	Preparation and characterization of DDT and its analogues, Preparation and characterization of oxime ether; Application of insecticide in crop- calculation, protective measures, field observations-phytotoxicity, bio-efficacy, etc; Preparation and characterization of some important intermediate compounds for synthesis of insecticides.
2nd Semester	Theory	Practical
AC 551: Synthetic	UNIT I: Introduction to important plant	

agrochemicals for fungi and nematode management (2 + 1)	pathogenic fungi and historical development of fungicides. Classification based on chemical nature and mode of action, S, Cu, Hg, Sn, As and dithiocarbamate fungicides. UNIT II: Benzene derivatives, phenol, quinone, polyhalogen, alkane sulfenyl group, carboxamide and dicarboximide group of fungicides. UNIT III: Organophosphorus fungicides (examples, heterocyclic fungicides: Imidazole, benzimidazole, triazole, oxazole, thiazole, pyridine, pyrimidine, quinoline, quinoxaline, morpholine etc.). UNIT IV: Fungicides of formamide group, alkane, alkane carboxylic acid and other miscellaneous groups, Oxathins. Strobilurin fungicides and antibiotics. UNIT V: Introduction to importantplant parasitic nematodes and historical development of nematicides. Preparation, properties and uses of aliphatic halogen compounds. Methyl isocyanate liberators, organophosphates and carbamates. Preparation of heterocyclic fungicide, preparation of α, β-unsaturated ketone, pyrazoles and pyridine fungicides. Estimation of Dithiocarbamates by Kepel's method.	
AC 552: Synthetic agrochemicals for weed management (2 + 1) UNIT I: Introduction to agrochemicals for weed management or herbicides; classification of herbicides based on time of application, mode of action and selectivity; chemistry of phenoxy acid herbicides - 2,4-D, MCPA,	Preparation of 2,4-D, Its characterization by m.p, TLC, NMR, etc., derivatization of 2,4-D and its characterization; Introduction to Weeds: Field visit: weed identification, herbarium preparation, application of herbicide- calculation, protective measures, field observations-phytotoxicity, bio-efficacy, etc.; Preparation and characterization of some important intermediate compounds for synthesis of herbicides.	

Dichlorprop, Mecoprop, Fenoprop, Phenoxy butyric acid. Factors governing the activity or structure activity relationship of urea derivatives - Linuron, Monuron, Diruon, Metoxuron, Isoproturon, their synthesis and mode of action; chemistry of bipyridylium herbicides - Diquat, Paraquat; organophosphates. UNIT II: Aliphatic and benzoic acid herbicides; Chemistry of carbamates and thiocarbamates; Sulfonyl carbamates, Biscarbamates; Chemistry of amides and anilides. UNIT III: Chemistry of some important herbicides belonging to Triazines, Pyridines, Pyridazines, Pyrimidines, Oxadiazoles. UNIT IV: Chemistry of some important herbicides belonging to Diphenyl ethers, Phenoxy-phenoxy		

acid herbicides, Sulfonyl ureas, Imidazolinones; Structure activity relation, mode of action, selectivity. UNIT V: Herbicide uptake, translocation and selectivity; Herbicide safeners- discovery, classification and chemistry of some important members (Naphthalic anhydride, Phthalic anhydride, N,N-diallyl Chloroacetamide, Dichloroacetamides, Cyometrinil, Flurazole, etc.); Relative potency, Prosafeners, Safeners . UNIT VI: Plant Growth Regulators, Auxins, Gibberallin - synthesis, determination of structures and structure activity relationships. Biosynthesis of Auxins and Gibberallin,Wain's three-point attachment theory, Cytokinins, Brassionosteroids.		
AC 553: Spectroscopic and chromatographic techniques (2 + 2)	UNIT I: Absorption spectroscopy: (UV, Visible and IR Spectrophotometry their theory, principle, instrumentation and application in structure elucidation of organic compounds and analysis). UNIT II: Theory, principle, instrumentation	UV-Vis Spectroscopy, IR Spectroscopy, Mass Spectrometry, NMR Spectrometry, Structure elucidation using UV, IR, MS and NMR data. Chromatography-

	and application of NMR and mass spectroscopy in structure elucidation of organic compounds. UNIT III: Separation science and technology: Paper, column, thin-layer, ion- exchange and flash chromatography - principle, adsorbents, their preparation, properties mechanism of retention and application in isolation of organic compounds. GC, LC and HPTLC - principle, instrumentation and application for separation of organic compounds. UNIT IV: Theory and practice of recent techniques in NMR: C^{13} and 2D for structure elucidation of organic compounds. Tandem techniques such as GC-MS, LC-MS for validation of results of analysis by GC, LC, GPC and HPTLC.	GLC, HPLC and HPTLC.
AC 554: Pesticide residue chemistry (2 + 2)	UNIT I: Pesticide residue– concept, types, source; Significance and safety considerations: risk assessment and management, hazard identification etc. Definitions with examples: Aged residue, immbolized residue, dislodgable residue, exposure, adverse effect, bioaccumulation, food chain, acceptable daily intake, theoretical daily intake, estimated daily intake, estimated maximum daily intake, biomagnification, food chain, zero tolerance, persistence, dissipation, predicted no effect concentration, raw agricultural commodity. UNIT II: Monitoring of pesticide residue in agricultural produce and environment. Planning and layout of experiments. Application of analytical techniques for residue analysis such as spectrophotometry, chromatography including GC, HPLC, GC-MS, LC-MS and ELISA. UNIT III: Qualitative and quantitative analysis. Accuracy and precision. Standardization of extraction and clean up conditions to achieve maximum recovery. Limit of quantification, limit of detection, limit of determination, multiresidue analysis by quick, easy, cheap, effective, rapid and safe (QuEChERS) method and GC/LC-MSMS method. Radiotracer	Identification of Organochlorine insecticides in water by TLC, Identification of Carbamate insecticides in water by TLC, Estimation of organophosphorus/ carbamate insecticide residues by UV-VIS spectroscopic method, Use of GLC, HPLC, GC-MS, LC-MS etc. for estimation of various pesticides in food and environmental commodities using QuEChERS technique.

	techniques in residue analysis. UNIT IV: Method validation and performance verification. Documentation and audit of laboratory data. Laboratory proficiency testing, Codex Alimentarius Commission and its functions, Fixation and calculation of MRL. Introduction to ISO 17025. GLP principles, quality control and assurance in pesticide residue laboratories. UNIT V: Basic statistics and experimental design, Statistical interpretation of residue data: Residual Half-life, Safe Waiting Period; Legal implications.	
3rd Semester	Theory	Practical
AC 601: Introduction to agrochemical formulation (1 + 1)	Unit I: Formulation of Agrochemicals - Definition, utility and classification; General steps in preparation; Components of agrochemical formulation: Carriers, diluents, solvents & surfactants – their properties; Carrier-Pesticide incompatibility Unit II: Properties and method of preparation of solid & liquid formulation; Dust, Granule, EC & WP Unit III: Biopesticide Formulation-Specification, type and guidelines for preparation; Seed treatment formulation Unit IV: Quality Control and Quality Assurance, Analysis, Regulatory Agencies Unit V: Packaging and Labeling of agro-formulations: Materials, Specifications, Regulations; Needs for low literacy regions, etc.	Preparation of standard hard water and its suitability judgment in formulation analysis; Laboratory equipment used in formulation research;Test for Physico-chemical properties of formulations: pH; Acidity; Alkalinity; Emulsion stability; Suspensibility; Foaming; Wettability, etc.; Preparation of formulation: Powder, EC; Application technology: Sprayers, Dusters, Aerosol generators, Granule applicators, etc.
4th Semester	Theory	Practical

AC 651: Agrochemical regulation, quality control and management (2 + 0)	UNIT I: Current status of plant production and plant protection agro-chemicals, Fertilizer Control Order, The Insecticides Act, laws, acts and regulations for the social security and welfare of industrial labour, Acts relating to protection of air, water and the general environment. UNIT II: Quality, quality control, role of industry, government, etc., imitation and adulteration in the developing world, hints for the set up of a quality control laboratory in pesticide formulation as per BIS specifications. UNIT III: Business management including market, budget and financial management, manpower planning, etc. UNIT IV: Interaction with industry for practical knowledge on the above topics.	