BANARAS HINDU UNIVERSITY

INSTITUTE OF AGRICUTURAL SCIENCES

PROSPECTUS OF STUDIES

B.Sc.(Ag.)/M.Sc.(Ag.)/Ph.D.COURSES

CONTENTS

INSTITUTE OF AGRICULTURAL SCIENCES

ORDINANCES

These ordinance shall be called "Ordinances governing B.Sc. (Ag.) M.Sc. (Ag.) and Ph.D. degree programmes in the faculty of Agriculture, 2004. The Ordinance shall be divided into the following part:

PART I Admission, Course requirements and Examinations

PART II Courses and Syllabi

Ordinances Part I : Admission, Course requirements and Examinaions

Clause Nos.

PART – II : COURESES AND SYLLABI

B.Sc.(Ag.)/M.Sc.(Ag.)/Ph.D. COURSES

AGRICULTURAL ECONOMICS

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)

B.Sc. (Ag.) Courses

Core Courses

AEC-121: Principles of Agricultural Economics	2 (2+0)
AEC-211:Agricultural Finance and Co-Operation	2(1+1)
AEC-221: Agricultural Marketing, Trade and Prices	2 (1+1)
AEC-311: Fundamentals of Agri-Business Management	2 (1+1)
AEC-321: Production Economics and Farm Management	**2 (1+1)**

M.Sc. (Ag.) Courses

Core Courses

AEC 501*	Micro Economic Theory And Applications	2(2+0)
AEC 502*	Macro Economics and Policy	2(2+0)
AEC 503*	Evolution of Economic Thought	1(1+0)
AEC 504*	Agricultural Production Economics	2(1+1)
AEC 505*	Agricultural Marketing & Price Analysis	3(2+1)
AEC 506*	Research Methodology For Social Sciences	2(1+1)
AEC 507*	Econometrics	3(2+1)

AEC 508*	Linear Programming	2(1+1)
AEC 509*	Agricultural Finance And Project Management	3(2+1)
AEC 510	International Economics	2(1+1)
AEC 511	Agricultural Development And Policies	1(1+0)
AEC 512	Institutional Economics	2(2+0)
AEC 513	Natural Resource And Environmental Economics	2(1+1)
AEC 514	Intellectual Property Management	1(1+0)
AEC 515	Rural Marketing	2(2+0)
AEC 516	Commodity Futures Trading	2(2+0)
AEC517/ABM513#	Computer Applications For Agri-Business & Economics	3(1+2)
AEC 591*	Master's Course Seminar	1(1+0)
AEC 592*	Master's Research Seminar	(US/S***)
AEC 599 *	Master's Research	20

Ph.D.

Core Courses

AEC 601**	ADVANCED MICRO-ECONOMIC ANALYSIS	2(1+1)
AEC 602**	ADVANCED MACRO-ECONOMIC ANALYSIS	2(2+0)
AEC 603**	ADVANCED ECONOMETRICS	3(2+1)
AEC 604**	ADVANCED PRODUCTION ECONOMICS	3(2+1)
AEC 605**	QUANTITATIVE DEVELOPMENT POLICY ANALYSIS	2(1+1)
AEC 606**	ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS	3(2+1)
AEC 607	NATURAL RESOURCE MANAGEMENT	2(1+1)
AEC 608	ENVIRONMENTAL ECONOMICS	2(2+0)

AEC 690**	SYNOPSIS SEMINAR	US/S***
AEC 691**	DOCTORAL SEMINAR I	1(1+0)
AEC 692**	DOCTORAL SEMINAR II	1(1+0)
AEC 693**	THESIS PRE SUBMISSION SEMINAR	US/S***
AEC 699**	DOCTORAL RESEARCH	45

B.Sc. (Ag.) Courses

Core Courses

AEC-121: Principles of Agricultural Economics **2 (2+0)**

Economics: Meaning, Definition, Subject matter, Divisions of Economics, Importance of Economics; Agricultural Economics: Meaning, Definition; Basic Concepts: Goods, Service, Utility, Value, Price, Wealth, Welfare. Wants: Meaning, Characteristics, Classifications of Wants, Importance. Theory of consumption: Law of Diminishing Marginal utility, Meaning, Definition, Assumption, Limitations, Importance. Consumer's surplus: Meaning, Definition, Importance. Demand: Meaning, Definition, Kinds of Demand, Demand schedule, Demand Curve, Law of Demand, Extension and Contraction Vs Increase and Decrease in Demand. Elasticity of Demand: Types of Elasticity of Demand, Degrees of price elasticity of Demand, Methods of Measuring Elasticity, Factors influencing elasticity of Demand, Importance of Elasticity of Demand. Welfare Economics: Meaning, Pareto's optimality. National Income: Concepts, Measurement. Public Finance: Meaning, Principles. Public Resource: Meaning, Services Tax, Meaning, Classification of Taxes: Cannons of Taxation, Public expenditure: Meaning, Principles. Inflation: Meaning, Definition, Kinds of inflation.

AEC-211:Agricultural Finance and Co-Operation **2(1+1)**

Agricultural finance: nature and scope. Time value of money, Compounding and Discounting. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4R's 5C's and 7 P' s of credit, repayment plans. History of financing agriculture in India. Commercial banks, nationalization of commercial banks. Lead bank scheme, regional rural banks, scale of finance. Higher financing agencies, RBI, NABARD, AFC, Asian Development Bank, World Bank, Insurance and Credit Guarantee Corporation of India. Assessment of crop losses, determination of compensation. Crop insurance, advantages and limitations in application, estimation of crop yields. Agricultural cooperation: philosophy and principles. History of Indian cooperative Movement, pre-independence and post independence periods, cooperation in different plan periods, cooperative credit structure: PACS, FSCS. Reorganization of cooperative credit structure in Andhra Pradesh and single window system. Successful cooperative systems in Gujarat, Maharastra. Punjab etc.

Practical: Factors governing use of Capital and identification of credit needs; Time value of money, Compounding and discounting; Tools of financial management, Balance sheet, Income statement and cash flow analysis; Estimations of credit needs and determining unit costs; Preparations and analysis of loan proposals; Types of repayment loans; Study of financial institutions: PACS, DCCB, Apex Banks, RRBs, CBs, NABARD.

AEC-221: Agricultural Marketing, Trade and Prices **2 (1+1)**

Agricultural Marketing: Concepts and Definition, Scope and subject matter, Market and Marketing: Meaning, Definitions, Components of a market, Classification. Market structure, Conduct, performance. Marketing structure, Market functionaries or agencies, Producer's surplus: Meaning, Types of producers surplus, marketable surplus. Marketed surplus, importance, Factors affecting Marketable surplus. Marketing channels: Meaning, Definition, Channels for different products. Market integration, Meaning, Definition, Types of Market Integration. Marketing efficiency: Meaning, Definition, Marketing costs, Margins and price spread, Factors affecting the cost of marketing, Reasons for higher marketing costs of farm commodities, Ways of reducing marketing costs. Theories of International Trade: Domestic Trade, Free trade, International Trade, GATT, WTO, Implications of AOA. Market access, Domestic support, Export subsidies, EXIM-Policy & Ministerial conferences. Cooperative Marketing. State Trading. Ware Housing Corporation; Central and State, Objectives, Functions, Advantages. Food Corporation of India: Objectives and Functions. Quality Control, Agricultural Products, AGMARK. Price Characteristics of agricultural product process, Meaning, Need for Agricultural Price Policy. Risk in Marketing: Meaning and importance, Types of Risk in Marketing. Speculations and Hedging, Futures trading, Contract farming.

Practical: Identification of marketing channels; Study of Rythu Bazars, Regulated markets; Study of unregulated markets; Study of livestock markets; Price spread analysis; Visit to market institutions, NAFED; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

AEC-311: Fundamentals of Agri-Business Management **2 (1+1)**

Agribusiness: Meaning, Definition, Structure of Agribusiness, (Input, Farm, Product Sectors). Importance of Agribusiness in the Indian Economy, Agricultural Policy. Agribusiness Management, Distinctive features, Importance of Good Management, Definitions of Management. Management Functions, Planning, Meaning, Definition, Types of Plans (Purpose or Mission, Goals or Objectives, Strategies, Polices, Procedures, rules, programmes, Budget) characteristics of sound plan, Steps in planning, Organisation, Staffing, Directing, Motivation, Ordering, Leading, Supervision, Communication, control. Capital Management. Financial Management of Agribusiness: Importance of Financial Statements, Balance sheet, Profit and Loss Statement, Analysis of Financial statements. Agro-based Industries: Importance and Need, Classification of Industries, Types of Agro-based Industries, Institutional arrangement, Procedure to set up agro-based industries, Constraints in establishing agro-based industries. Marketing Management: Meaning, Definitions, Marketing Mix, 4Ps of Marketing. Mix, Market segmentation, Methods of Market, Product life cycle. Pricing policy, Meaning, pricing method. Prices at various stages of Marketing. Project, definitions, project cycle, Identification,

Formulation, Appraisal, Implementation, Monitoring and evaluation, Appraisal and Evaluation techniques, NPW, BCR, IRR, N/K ratio, sensitivity analysis, characteristics of agricultural projects: preparation of project reports for various activities in agriculture and allied sectors: Dairying, poultry, fisheries, agro-industries etc.

Practical: Study of input markets: seed, fertilizers, pesticides. Study of output markets, grains, fruits, vegetables, flowers. Study of product markets, retail trade commodity trading, value added products. Study of financing institutions cooperatives commercial banks, RRBs, Agribusiness Finance Limited, NABARD; Preparations of projects, Feasibility reports; Project appraisal techniques; Case study of agro-based industries.

AEC-321: Production Economics and Farm Management **2 (1+1)**

Production Economics: Meaning, Definition, Nature and Scope of Agricultural Production Economics. Basic concepts and terms. Concepts of Production. Production Functions: Meaning, Definition, Types. Laws of returns: Increasing, Constant and decreasing. Factor Product Relationship. Determination of optimum input and output. Factor relationship. Product relationship. Types of enterprise relationships. Returns to scale: Meaning, Definition, Importance. Farm Management. Economic principles applied to the Organisations of farm business. Types and systems of farming. Farm planning and budgeting. Risk and uncertainty. Farm budgeting. Linear programming: Assumptions, Advantages and Limitations of Linear programming.

Practical: Computation of cost concepts; Methods of computation of depreciation; Analysis of Net worth statement; Farm inventory analysis; Preparation of farm plans and budgets; Types of farm records and accounts; Preparation of profit and loss account; Break, Even analysis; Economics analysis of different crop and livestock enterprises; Application of Farm Management Principles.

M.Sc. (Ag.) Courses

Core Courses

AEC 501 MICRO ECONOMIC THEORY AND APPLICATIONS **2(2+0)**

Theory

UNIT I Theory of Consumer Behaviour - Cardinal Utility Approach - Ordinal Utility Approach – Income effect and substitution effect – Applications of Indifference curve approach - Revealed Preference Hypothesis – Consumer surplus - Derivation of Demand curve – Elasticity of demand.

UNIT II Theory of Production - Production functions – Returns to scale and economies of scale – Technical progress – Theory of Costs – Cost curves– Profit maximization and cost minimization – Derivation of supply curve – Law of Supply – Producers' surplus.

UNIT III Market Equilibrium - Behavior of Firms in Competitive Markets - Perfect Competition- Effect of

Taxation and Subsidies on market equilibrium - Monopoly- Monopolistic - Oligopoly- Theory of Factor Markets.

UNIT IV General Equilibrium Theory - Welfare Economics - Pareto Optimality – Social welfare criteria - Social Welfare functions.

AEC 502 MACRO ECONOMICS AND POLICY 2(2+0)

Theory

UNIT I Nature and Scope of Macro Economics - Methodology and Keynesian Concepts National Income - Concepts and measurement- Classical theory of Employment and Say's Law-Modern theory of Employment and Effective Demand.

UNIT II Consumption function- Investment and savings - Concept of Multiplier and Accelerator - Output and Employment - Rate of interest - Classical, Neo classical and Keynesian version- Classical theory Vs Keynesian theory - Unemployment and Full employment.

UNIT III Money and classical theories of Money and Price - Keynesian theory of money and Friedman Restatement theory of money - Supply of Money - Demand for Money -Inflation: Nature, Effects and control.

UNIT IV IS & LM frame work - General Equilibrium of product and money markets Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy - Central banking.

UNIT V Business cycles - Balance of Payment - Foreign Exchange Rate determination.

AEC 503 EVOLUTION OF ECONOMIC THOUGHT 1(1+0)

Theory

UNIT 1 Approaches for the study of history of economic thought – Absolutist vs. Relativist approaches – Evolution of Economic Thought vs. Economic History. Ancient economic thought – medieval economic thought – mercantilism – physiocracy – Forerunners of Classical Political Economy.

UNIT II Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo) – Critics of Classical Thoughts- Socialist critics – Socialist and Marxian Economic Ideas – Austrian School of Thought – Origins of Formal Microeconomic Analysis – William Stanley Jevons, Cournot and Dupuit.

UNIT III The birth of neoclassical economic thought – Marshall and Walras – General Equilibrium Theory - Welfare Theory – Keynesian economics.

UNIT IV The Era of globalization – Experiences of developing world - Rigidity of the past vs. emerging realism – The changing path of international Institutions to economic growth and development approaches.

UNIT V Economic Thought in India – Naoroji and Gokhale – Gandhian Economics - Economic thought of independent India – Nehru's economic philosophy - Experiences of the Structural adjustment programmes of the post liberalization era.

AEC 504 AGRICULTURAL PRODUCTION ECONOMICS 2(1+1)

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Theory

UNIT I Nature, scope and significance of agricultural production economics- Agricultural Production processes, character and dimensions-spatial, temporal - Centrality of production functions, assumptions of production

functions, commonly used forms - Properties, limitations, specification, estimation and interpretation of commonly used production functions.

UNIT II Factors of production, classification, interdependence, and factor substitution Determination of optimal levels of production and factor application -Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination.

UNIT III Cost functions and cost curves, components, and cost minimization -Duality theory – cost and production functions and its applications -Derivation of firm's input demand and output supply functions - Economies and diseconomies of scale.

UNIT IV Technology in agricultural production, nature and effects and measurement - Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement - Nature and sources of risk, modeling and coping strategies.

Practical

Different forms of production functions -specification, estimation and interpretation of production functions – returns to scale, factor shares, elasticity of production - physical optima-economic optima-least cost combination-optimal product choice- cost function estimation, interpretation-estimation of yield gap - incorporation of technology in production functions- measuring returns to scale-risk analysis through linear programming.

AEC 505 AGRICULTURALMARKETING AND PRICE ANALYSIS 3(2+1)

Theory

UNIT I Review of Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical coordination.

UNIT II Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming and Retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -Performance and Strategies -Market infrastructure needs, performance and Government role - Value Chain Finance.

UNIT III Role of Information Technology and telecommunication in marketing of agricultural commodities - Market research-Market information service electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) – Market extension.

UNIT IV

Spatial and temporal price relationship – price forecasting – time series analysis – time series models – spectral analysis. Price policy and economic development – non-price instruments.

UNIT V

Theory of storage - Introduction to Commodities markets and future trading - Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis - Role of Government in promoting commodity trading and regulatory measures.

Practical

Supply and demand elasticities in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Marketing structure analysis through concentration ratios. Performance analysis of Regulated market and marketing societies. Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products. Chain Analysis - quantitative estimation of supply chain

efficiency - Market Intelligence – Characters, Accessibility, and Availability Price forecasting. Online searches for market information sources and interpretation of market intelligence reports – commodity outlook - Technical Analysis for important agricultural commodities - Fundamental Analysis for important agricultural commodities - Presentation of the survey results and wrap-up discussion.

AEC 506 RESEARCH METHODOLOGY FORSOCIAL SCIENCES 2(1+1)

Theory

UNIT I Importance and scope of research in agricultural economics. Types of research - Fundamental vs. Applied. Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.
UNIT II Hypothesis – meaning - characteristics - types of hypothesis – review of literature – setting of Course Objective and hypotheses - testing of hypothesis.
UNIT III Sampling theory and sampling design – sampling error - methods of sampling – probability and non-probability sampling methods - criteria to choose. Project proposals – contents and scope – different types of projects to meet different needs – trade-off between scope and cost of the study. Research design and techniques – Types of research design.
UNIT IV Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing.
UNIT V Coding editing – tabulation – validation of data. Tools of analysis – data processing. Interpretation of results – Preparing research report / thesis – Universal procedures for preparation of bibliography – writing of research articles.

Practical

Exercises in problem identification. Project proposals – contents and scope. Formulation of Objective and hypotheses. Assessment of data needs – sources of data – methods of collection of data. Methods of sampling – criteria to choose – discussion on sampling under different situations. Scaling Techniques – measurement of scales. Preparation of interview schedule - Field testing. Method of conducting survey. Exercise on coding, editing, tabulation and validation of data. Preparing for data entry into computer. Hypothesis testing – Parametric and Non-Parametric Tests. Exercises on format for Thesis / Report writing. Presentation of the results.

AEC 507 ECONOMETRICS 3(2+1)

Theory

UNIT I Introduction – relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis.
UNIT II Basic two variable regression - assumptions estimation and interpretation-approaches to estimation - OLS, MLE and their properties - extensions to multi variable models-multiple regression estimation and interpretation.
UNIT III Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches - model misspecification.
UNIT IV Use of dummy variables-limited dependent variables – specification, estimation and interpretation.

UNIT V Simultaneous equation models – structural equations - reduced form equations - identification and approaches to estimation.

Practical

Single equation two variable model specification and estimation - hypothesis testing-transformations of functional forms and OLS application-estimation of multiple regression model - hypothesis testing - testing and correcting specification errors - testing and managing Multicollinearity - testing and managing heteroscedasticity - testing and managing autocorrelation - estimation of regressions with dummy variables - estimation of regression with limited dependent variable - identification of equations in simultaneous equation systems.

AEC 508 LINEAR PROGRAMMING **2(1+1)**

Theory

UNIT I Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems. UNIT II Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farms and non farm problems as linear programming models and solutions. UNIT III Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming. UNIT IV Game Theory- Concepts of game theory, two person constant sum, zero sum game, saddle point, solution to mixed strategies, the rectangular game as Linear Programme.

Practical

Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex method. Formulation of the simplex matrices for typical farm situations.

AEC 509 AGRICULTURAL FINANCE AND PROJECT MANAGEMENT **3(2+1)**

Theory

UNIT I Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing - Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

UNIT II Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

UNIT III Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

UNIT IV Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net

work Techniques – PERT and CPM.
UNIT V Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes - yield loss and weather based insurance and their applications.

Practical

Development of Rural Institutional Lending - Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving- : An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme- Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Performance of Micro Financing Institutions - NGO's and Self-Help Groups, Identification and formulation of investment projects, Project appraisal techniques – Undiscounted Measures and their limitations. Project appraisal techniques – Discounted Measures, Network techniques – PERT and CPM for project management, Case Study Analysis of an Agricultural project, Financial Risk and risk management strategies – crop insurance schemes, Financial instruments and methods – E banking, Kisan Cards and core banking.

AEC 510 INTERNATIONAL ECONOMICS 2(1+1)

Theory

UNIT I Scope and Significance of International Economics - The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium) – Equilibrium in a Simple Open Economy - Possibility of World Trade - Trade gains and Trade Equilibrium.
UNIT II Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.
UNIT III Ricardian Model of Trade- Specific Factors Model- Heckscher - Ohlin Model - Trade Creation and Trade Diversion – Offer Curve - Export Supply Elasticity and Import Demand Elasticity - Comparative Advantage and Absolute Advantage.
UNIT IV Official Exchange Rate and Shadow Exchange Rate - Walra's Law and Terms of Trade – Trade Blocks.
UNIT V IMF, World Bank, IDA, IFC, ADB – International Trade agreements – Uruguay Round – GATT – WTO.

Practical

Producer's Surplus, Consumer's Surplus, National Welfare under Autarky and Free Trade Equilibrium with small and large country assumption- Estimation of Trade Gains- Estimation of competitive and comparative measures like NPC, EPC, ERP and DRC- Estimation of Offer Curve Elasticity- Estimation of Effect of Tariff, Export Subsidy, Producer Subsidy, Import Quota and Export Voluntary Restraints on National Welfare- Estimation of Ricardian Model - Estimation of Effect of Trade under Specific Factor Model- Estimation of trade Equilibrium under Heckscher -Ohlin model - Trade Creation and Diversion.

AEC 511 AGRICULTURAL DEVELOPMENT AND POLICIES 2(2+0)

Theory

UNIT I Development Economics – Scope and Importance - Economic development and economic growth - divergence in concept and approach - Indicators and Measurement of Economic Development – GNP as a

measure of economic growth – New Measures of Welfare – NEW and MEW – PQLI – HDI – Green GNP Criteria for under development – Obstacles to economic development – Economic and Non-Economic factors of economic growth.

UNIT II Economic development – meaning, stages of economic development, determinants of economic growth. Theories of economic growth – Ricardian growth model – The Harrod – Domar Model – The Neo classical Model of Growth – The Kaldor Model – Optimal Economic Growth – Recent Experiences of developing country economies in transition – Role of state in economic development – Government measures to promote economic development. Introduction to development planning.

UNIT III Role of agriculture in economic / rural development – theories of agricultural development – Population and food supply - need for sound agricultural policies – resource policies – credit policies – input and product marketing policies – price policies.

UNIT IV Development issues, poverty, inequality, unemployment and environmental degradation – Models of Agricultural Development – Induced Innovation Model - policy options for sustainable agricultural development.

UNIT V Globalization and the relevance of development policy analysis – The dilemma of free trade? – Free trade versus Protectionism- Arguments for protection. Arguments against protection. Role of protection in Developing Countries. WTO – Agreement on Agriculture - Contradictions of free trade - proponents and opponents policies in vulnerable sectors like agriculture – Lessons for developing countries.

AEC 512 INSTITUTIONAL ECONOMICS **1(1+0)**

Theory

UNIT I Old and New Institutional Economics - Institutional Economics Vs Neo- classical Economics. Definition of institutions – Distinction between institutions and organizations - Institutional evolution

UNIT II Institutional change and economic performance - national and international economic institutions. Transaction cost economics – Transaction costs and the allocation of resources. Transaction costs and efficiency. Asymmetric information - Moral hazard and Principal-Agent problem.

UNIT III Free rider problem – path dependency – Interlinked transactions. Collective action and the elimination of free-rider problem - The logic of collective action and its role in reducing free rider problem – theory of Groups. Rent seeking – interest groups and policy formulation.

UNIT IV Economic analysis of property rights- property rights regimes – private property – State Property - Common property Resources (CPRs) – public goods and club goods.

UNIT V Special features of institutional arrangements in agriculture – Transaction costs in agriculture - Case Studies - Theories of agrarian institutions - tenancy institutions.

AEC 513 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS **2(1+1)**

Theory

UNIT I Concepts, Classification and Problems of Natural Resource Economics – Economy
Environment interaction – The Material Balance principle, Entropy law-Resources Scarcity - Limits to Growth - Measuring and mitigating natural resource scarcity – Malthusian and Recardian scarcity – scarcity indices - Resource Scarcity and Technical Change.

UNIT II Theory of optimal extraction renewable resources –economic models of oil extraction- efficiency - time

path of prices and extraction - Hotelling's rule, Solow-Harwick's Rule. Theory of optimal extraction exhaustible resources – economic models of forestry and fishery.

UNIT III Efficiency and markets – market failures - externalities – types - property rights – transaction costs – Coase's theorem and its critique - public goods - common property and open access resource management - Collective action.

UNIT IV Environmental perspectives - biocentrism, sustainability, anthropocentrism -Environmental problems and quality of environment - Sources and types of pollution -air, water, solid waste, land degradation – environmental and economic impacts - Economics of pollution control - efficient reduction in environmental pollution.

UNIT V Environmental regulation – economic instruments - pollution charges - Pigovian tax - tradable permits – indirect instruments - environmental legislations in India.

UNIT VI Concept of sustainable development - Economic Perspective - Indicators of sustainability Relation between development and environment stress-Environmental Kuznet's curve Environmental Accounting – resource accounting methods - International Environmental Issues – climate change – likely impacts mitigation efforts and international treaties.

Practical

Exhaustible resource management –optimum rate of oil extraction. Renewable resource management – optimum harvest of Forestry/fishery. Exercise on pollution abatement –I. Exercise on pollution abatement –II. Concepts in valuing the environment. Taxonomy of valuation techniques. Productivity change method – substitute cost method - Hedonic price method - Travel cost method -Contingent valuation methods. Discount rate in natural resource management. Environment impact assessment Visit to Pollution Control Board.

AEC 514 INTELLECTUAL PROPERTY MANAGEMENT **1(1+0)**

Theory

UNIT I World Trade Organization- Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - Importance of Intellectual Property Management - IPR and Economic growth- IPR and Bio diversity -Major areas of concern in Intellectual Property Management -Technology Transfer and Commercialization-Forms of different Intellectual Properties generated by agricultural research.
UNIT II Discovery *versus* Invention - Patentability of Biological Inventions - Method of Agriculture and Horticulture- procedure for patent protection: Preparatory work. Record keeping, writing a patent document, filing the patent document -Types of patent application-patent application under the Patent cooperation treaty (PCT).
UNIT III Plant genetic resources -Importance and conservation - Sui Generic System -Plant Varieties Protection and Farmers Rights Act- Registration of Extant varieties -Registration and protection of New Varieties / Hybrids / Essentially Derived Varieties - Dispute prevention and settlement -Farmers' Rights.
UNIT IV Trademark- Geographical Indications of Goods and Commodities – Copy rights-Designs – Biodiversity Protection.
UNIT V Procedures for commercialization of technology - Valuation, Costs and Pricing of Technology- Licensing and implementation of Intellectual Properties- Procedures for commercialization – Exclusive and non exclusive marketing rights-Research Exemption and benefit sharing .

AEC 515 RURAL MARKETING **2(2+0)**

Theory

UNIT I Concept and scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India.
UNIT II Environmental factors - socio-cultural, economic and other environmental factors affecting rural marketing.
UNIT III Rural consumer's behaviour - behavior of rural consumers and farmers; buyer characteristics and buying behaviour; Rural v/s urban markets.
UNIT IV Rural marketing strategy - Marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning; product mix, pricing Course Objective, pricing policy and pricing strategy.
UNIT V Product promotion - Media planning, planning of distribution channels, and organizing personal selling in rural market in India.

AEC 516 COMMODITY FUTURE TRADING **2(2+0)**

Theory

UNIT I History and Evolution of commodity markets – Terms and concepts: spot, forward and futures Markets –

factors influencing spot and future markets. Speculatory mechanism in commodity futures.
UNIT II Transaction and settlement – delivery mechanism - role of different agents - trading strategies -potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets. UNIT III Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features. UNIT IV Important global and Indian commodity exchanges - contracts traded – special features -Regulation of Indian commodity exchanges - FMC and its role.
UNIT V Fundamental Vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.

AEC 517/ ABM 513: COMPUTER APPLICATIONS FOR AGRI-BUSINESS & ECONOMICS# 3(2+1)

Contents
UNIT I Concept of Computers- Brief History of Computers, Generation and Its Evolution, Characteristics of Computers, Hardware and Software, introduction to computer languages, Main Areas of Computers and their Applications; Types of Computers Analog, Digital, Hybrid, General Purpose and Special Purpose Computers, Micro Computers, Mini-Computers, Main-frame Computers, and Super Computers.
UNITII
Input-Output Devices, Storage Units (Disks, CD-ROM, DVD-ROM, Blue Ray Disk and tapes), Memory Types (Cache, RAM, ROM), Memory Units, Generation and types of Microprocessor.
UNITIII
Data and Information – Data Definition, Data Processing Systems, Data Type Numeric, Alphabetic, Audio, Graphic, and Video and Their Presentation; Data Processing- Introduction to Data Processing, Computer as a Tool For Data Processing, Data Processing Cycle, Data Processing Techniques, Data Analysis, Data Inputs and Outputs, Data Processing Management, , Data Security.
UNIT IV Introduction to Operating Systems, MS Windows, and UNIX, MS Office (MS Word, MS Power Point, MS Excel, MS-Access and use of various management software's Like SPSS. UNIT IV Introduction to LAN, WAN, MAN, internet and search engines; Introduction to agri-portals like agriwatch.com, agmarknet.nic.in, echaupal.com
Practical : Operation of various systems and software e.g. MS Windows, and UNIX, MS Office (MS Word, MS Power Point, MS Excel, MS-Access and use of various management software's Like SPSS. Data Processing and analysis. Network setting and practical utility of networking in agricultural economics.

Ph.D. COURSES

AEC 601 ADVANCED MICRO ECONOMIC ANALYSIS 2(1+1)

Theory

UNIT I Theory of consumer behaviour – Duality in consumer theory - expenditure function and indirect utility function - Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumers' Welfare – Consumer's Surplus, Compensating Variation and Equivalent Variation - Dynamic versions of demand functions – Integrability of demand functions. Demand Models – Linear Expenditure System, Almost Ideal Demand System. Applications of consumer theory – Household model and time allocation – Labour supply decisions by households.
UNIT II Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models – collusive and non-collusive models of oligopoly - Cournot model, Chamberlin model, Stackleberg solution.
UNIT III General equilibrium theory – Conceptual overview - General equilibrium conditions with Production and Consumption. Existence, Uniqueness and Stability of general competitive equilibrium. Walrasian general equilibrium – Mathematical derivation of conditions for general equilibrium.
UNIT IV Market failure - Incomplete markets - Asymmetric information – Principal-Agent problem, adverse selection and moral hazard. Externalities – Network externalities, Public goods – Optimal provision of public goods.
UNIT V Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics, Pareto conditions of maximum welfare – Criteria for social welfare - Social Welfare functions, Social versus Private costs and benefits.

Practical

Problems in consumer utility maximization – Estimation of income and substitution effects; Estimation and comparison of Consumer's surplus, equivalent variation and compensating variation. Estimation of demand models – Derivation and estimation of labour supply equations from household models comparative static analysis in consumption. Advanced problem solving in price determination under perfect competition, monopoly, oligopoly and monopolistic competition. Game theory models. Problems solving in General Equilibrium Theory and Welfare Economics. Problems in public goods provision.

AEC 602 ADVANCED MACRO ECONOMICS ANALYSIS 2(2+0)

Theory

UNIT I Review of Macro Economics concepts-Comparative statistics- Keynesian theory-Consumption Function and Theories of Consumption -Saving Function and Theories of Saving. UNIT II Theories of Investment-Savings and Investment Equality - IS - LM Framework and its mand for and Supply of Money-Monetary Policy in the static model – Inflation.
UNIT III Stagflation and Supply side Economics - Theory of Unemployment - Phillips Curve controversy - Inflation, Productivity and distribution - Fiscal policy: Effectiveness and Problems. UNIT IV Social Accounting Matrix Framework - General Equilibrium Analysis -Neo classical Macro Economics - Stochastic Macro Economics.
UNIT V BOP & Adjustment Policies - Foreign Exchange Policy - Foreign sector : Capital and Current Account - Impact of WTO on Indian Economy - Impact of IMF & IBRD on Indian Economy - Review of Macro Economic Policies in India.

AEC 603 ADVANCED ECONOMETRICS 3(2+1)

Theory

UNIT I Review of classical regression model – review of hypothesis testing – restrictions on parameters – single equation techniques.
UNIT II Ordinary least squares – weighted least squares - generalized least squares – method of principal components – instrumental variables method - maximum likelihood method - errors in variables, non-linearity and specification tests – non spherical error terms.
UNIT III Dummy variables - Qualitative and truncated dependent variables - limited dependent variables –LPM, probit and logit models, their multinomial extensions.
UNIT IV Autoregressive distributed lag models – panel data fixed and random effects models and their extensions.
UNIT V Simultaneous equation methods –identification – estimation by indirect least squares
2SLS, PIML, SURE, 3SLS.

Practical

Estimation of multiple regression model - GLS estimation methods - testing misspecification errors – Testing and Managing multicollinearity, heteroscedasticity and autocorrelation - estimation of LPM, Logit and Probit models - comparing two regressions - Chow test - estimation of distributed lag models – panel data random and fixed effects models - Indirect least squares 2SLS, SURE, 3SLS, estimation of simultaneous equation models

AEC 604 ADVANCED PRODUCTION ECONOMICS 3(2+1)

Theory

UNIT I Agricultural Production process – Relationship between farm planning and production economics-scope of agricultural production and planning-methods/procedures in agro-economic research and planning.

UNIT II Production functions, components, assumptions, properties and their economic interpretation - Concepts of homogeneity, homotheticity, APP, MPP, elasticities of substitution and their economic relevance – Production relations –optimality-Commonly used functional forms, nature, properties, limitations, estimation and interpretation -linear, Spillman -Cobb Douglas, quadratic, multiplicative (power) functional forms - Translog, and transcendental functional forms -CES, production functional forms-Conceptual and empirical issues in specification, estimation and application of production functions- Analytical approaches to economic optimum - Economic optimum – determination of economic optimum with constant and varying input and output prices- Economic optimum with production function analysis - input use behaviour.

UNIT III Decision making with multiple inputs and outputs – MRT and product relationship-cost of production and adjustment in output prices-single input and multiple product decisions- Multi input, and multi product production decisions - Decision making with no risk -Cost of wrong decisions - Cost curves – Principles and importance of duality theory - Correspondence of production, cost, and profit functions - Principles and derivation of demand and supply functions

UNIT IV Technology, input use and factor shares -effect of technology on input use-decomposition analysis-factor

shares-estimation methods- Economic efficiency in agricultural production – technical, allocative and economic efficiency – measurement -Yield gaps analysis – concepts and measurement - Risk and uncertainty in agriculture – incorporation of risk and uncertainty in decision making – risk and uncertainty and input use level-risk programming.

UNIT V Simulation and programming techniques in agricultural production-Multiple Course Objective Programming – Goal programming and Compromise programming – applications.

Practical

Estimation of different forms of production functions- Optimal input and product choice from estimated functions-Derivation of demand and supply functions and estimation-Estimation of cost function and interpretations-Optimal product and input choice under multi input and output system-Estimation of factor shares from empirical functions estimated-Estimating production functions incorporating technology changes: Decomposition analysis and incorporation of technology-Estimation of efficiency measures – Stochastic, probabilistic and deterministic frontier production functions-Risk programming – MOTAD-Quadratic programming-Simulation models for agricultural production decisions-Goal programming – Weighted, lexicographic and fuzzy goal programming-Compromise programming.

AEC 605 QUANTITATIVE DEVELOPMENT POLICYANALYSIS 2(1+1)

Theory

UNIT I Policy framework – goals, value, beliefs and welfare maximization. Market – Policy and State – State vs. Market – Failure of Policy – Failure of Markets - Rationale for Government Intervention. Role of Quantitative Policy Analysis.

UNIT II Demand analysis for policymaking – Alternative approaches to demand analysis – Policy implications. Supply response – Alternative approaches to measurement of supply response – Nerlovian models of supply response – Policy implications.

UNIT III Household behaviour and policy analysis – Household models.

UNIT IV Partial equilibrium analysis – Concept of reference prices – Price distortions – indicators and impact. Transaction costs – Implications for efficiency and productivity – Institutional solutions - Multi market approach to policy analysis.

UNIT V Social Accounting Matrices and multipliers -– Computable General Equilibrium models to assess economy wide impact of policy changes.

Practical

Review of criteria for policy evaluation – Estimation of price elasticities – Review of estimation of complete demand systems – Estimation of Nerlovian supply Response model – Review of Household models – Specification

and estimation of household models – Partial equilibrium analysis – Input–output table – Social Accounting Matrix – Construction of a SAM – computation of Multipliers – Multi Market Analysis – Review of Computable General Equilibrium Models.

AEC 606 ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS 3(2+1)

Theory

UNIT I Importance of market analysis in the agricultural system - types of marketing-advantages and disadvantages - quantitative estimation -the distinguishing characteristics and role of agricultural prices -data sources for agricultural products and prices - softwares used in market analysis.
UNIT II Role of various formal institutions in agricultural marketing - and functions - measuring their efficiency - public - private partnership - institutional arrangements. Successful case studies.
UNIT III Multi market estimation, supply response models. Market integration and price transmission - supply / value chain management. GAP analysis. Current trends in information in the changing agrifood system.
UNIT IV Agricultural commodity marketing -spot and futures- marketing of derivatives-speculation, hedging, swap, arbitrage etc. commodity exchanges - price discovery and risk management in commodity markets- Regulatory mechanism of futures trading.
UNIT V Lag operators and difference equations; stationary and stochastic processes; UNIT roots and cointegration; conditional heteroscedasticity: ARCH and GARCH models -forecast evaluation; methods of forecasting. price indices and econometric estimation and simulation.

Practical

Estimation of demand/ supply forecasting, supply chain / value chain analysis for different commodities - Commodity models- multi market estimation- time series analysis -market integration studies- price discovery price volatility estimation - commodity price forecasting using econometric softwares.

AEC 607 NATURAL RESOURCE MANAGEMENT 2(1+1)

Theory

UNIT I Natural resources - definition - characteristics and classification. Stock dynamics of renewable and non-renewable resources. Equation of motion for renewable and non-renewable resources. Fundamental equation of renewable resources.
UNIT II Growth curves of fishery and forest resources. The role of time preference in natural resource use. Simple two-period model of optimal use of renewable and non-renewable resources. Advanced models of optimal resource use – Static Vs. dynamic efficiency in natural resource use Applications of dynamic programming and optimal control.
UNIT III Economics of groundwater use - optimal extraction of groundwater. Analytical and numerical solutions for optimal inter-temporal allocation of natural resources. Optimal harvesting of single rotation and multiple rotation forests. Optimal management of fishery. UNIT IV Property rights in natural resources and their implication for conservation and management of natural resources. Management of common property natural resources – Institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource.

UNIT V Resource scarcity – Natural resource degradation – Poverty and resource degradation – Natural resource accounting - Pricing and valuation of natural resources – Natural resources policy.

Practical

Derivation of the fundamental equation of renewable resources-Estimation of growth curves and stock dynamics for fishery and forestry resources. Simple two period problem of optimal resource use – Numerical solution for simple two-period model of dynamic efficiency in natural resource extraction. Multi-period dynamic efficiency – Using Excel Solver in solving dynamic natural resource harvesting problems. Using analytical solution procedures for solving natural resource management problems – Optimal control.

AEC 608 ENVIRONMENTAL ECONOMICS 3(2+1)

Theory

UNIT I Environmental pollution as a consequence of market failure - Causes and consequences of market failure - Externalities - Public goods and externalities Economics of pollution – Private vs. Social cost of environmental pollution – Property rights, environment and development – Theory of environmental policy.
UNIT II Environmental cost benefit analysis - Environmental impact assessment techniques
Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.
UNIT III Economic growth and environmental cost - Growth oriented economic policies and their environmental impacts - Population and environmental quality - poverty and environmental degradation – Sustainable development – Indicators of sustainable development – Issues in sustainable development.
UNIT IV Environment, ecology and environmental accounting - Environmental pollution with respect to water and air - Land and forest resources related environmental pollution - Coastal externalities - Urbanization and environment - Basic approaches to environmental policy (Tax, subsidy, pollution permits etc.) Green taxes - Political economy of environmental regulation and management.
UNIT V Transboundary environmental problems - Economics of global warming, climate change and emission trading - Environment, international trade and development.

Practical

Contemporary global environmental global environmental issues, movement, policies, programmes, laws and other regulatory mechanisms - Criteria for evaluating the environment related projects and review of Environmental Impact Assessment (EIA) techniques - Recreation demand models of environmental valuation - Contingent valuation techniques - Environmental Resource Accounting Techniques - Discussion on the techniques dealing with air pollution and review of case studies on air pollution and its impacts - forest environment and wild life conservation - Green GDP and Green house insurance - Practical considerations and comparison of instruments of environmental policy - Non-point source pollution control methodologies - Environment in macroeconomic modeling - Meta-analysis, economic valuation and environmental economics - Multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems related to environment - Input output analysis, technology and the environment - Computable general equilibrium models for environmental economics and policy analysis.

AGRONOMY
List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)
B.Sc. (Ag.) Courses		
Core Courses		
AGR-111	Principles of Agronomy and Agricultural Meteorology	3(2+1)
AGR-112	Introductory Agriculture (Ancient Heritage, Agricultural Scenario and Gender Equity in Agriculture)	2(2+0)
AGR-121	Water Management	3(2+1)
AGR-211	Weed Management	3(2+1)
AGR-212	Organic Farming	2(1+1)
AGR-312	Field Crops - I *(Kharif)*	3(2+1)
AGR-321	Field Crops - II *(Rabi)*	3(2+1)
AGR-322	Farming Systems and Sustainable Agriculture	2(1+1)
M.Sc. (Ag.)		
Core Courses		
AGR 501*	Modern Concepts in Crop Production	3(3+0)
AGR 502*	Principles and Practices of Soil Fertility and Nutrient Management*	3(2+1)
AGR 503*	Principles and Practices of Weed Management	3(2+1)
AGR 504*	Principles and Practices of Water Management	3(2+1)
AGR 505	Agro meteorology and Crop Weather Forecasting	3(2+1)
AGR 506	Agronomy of Major Cereals and Pulses	3(2+1)

AGR 507	Agronomy of Oilseed, Fibre and Sugar Crops	3(2+1)
AGR 508	Agronomy of Medicinal, Aromatic and Under Utilized Crops	3(2+1)
AGR 509	Agronomy of Fodder and Forage Crops	3(2+1)
AGR 510	Agrostology and Agroforestry	3(2+1)
AGR 511	Cropping Systems	2(2+0)
AGR 512	Dryland Farming	3(2+1)
AGR 513	Principles and Practices of Organic Farming	3(2+1)
AGR 514	Field Experimentation	3(2+1)
AGR 515	Management of Problem Soils	3(2+1)
AGR 591	Master's Seminar	1(1+0)
AGR 599	Master's Research (Thesis)	20

Ph.D. COURSES

AGR 601	Current trends in Agronomy	3(3+0)
AGR 602	Crop Ecology	2(2+0)
AGR 603	Crop Production and System Modeling	3(2+1)
AGR 604	Advances in Crop Growth and Productivity	3(2+1)
AGR 605	Irrigation Management	3(2+1)
AGR 606	Advances in Weed Management	2(2+0)
AGR 607	Integrated Farming Systems	2(2+0)
AGR 608	Soil Conservation and Watershed Management	3(2+1)
AGR 609	Stress Crop Production	3(2+1)
AGR 691	Doctoral Seminar I	1(1+0)
AGR 692	Doctoral Seminar II	1(1+0)
AGR 699	Doctoral Research (Thesis)	45

B.Sc. (Ag.) Courses

Core Courses

AGR-111: Principles of Agronomy and Agricultural Meteorology 3(2+1)

Agronomy: definition, concept and scope of agronomy; national and international agricultural research institutes in India; tillage and its concept; crop stand establishment; plant geometry, manures and fertilizer and its effect on growth and yield ; cropping systems, agro- climatic and agro- ecological regions of India and UP; Agricultural meteorology: weather and climate, micro-climate, weather elements; earth atmosphere; solar radiation: nature, properties, depletion, solar constant and energy balance; atmosphere, temperature, factors affecting horizontal and vertical variation, global warming, air pressure variation; wind, factors affecting cyclones and anticyclones and general circulation; atmospheric humidity, vapour pressure and saturation; process of condensation, clouds: their formation and classification; formation of dew, fog, mist, snow, rain and hail; introduction to monsoon; basis of weather forecasting.

Practical

Study of tillage implements, practice of ploughing; study of seeding equipments, sowing methods; study of manures, fertilizers and green manure crops, methods of fertilizer application; study of intercultivation implements and their uses; participation in ongoing field operations; site selection of agromet observatory; measurement of temperature (ambient/soil), rainfall, evaporation atmospheric pressure, sunshine duration and solar radiation, wind direction and speed and relative humidity; study of weather forecasting and synoptic charts; introduction of remote sensing.

AGR-112: Introductory Agriculture (Ancient Heritage, Agricultural Scenario and Gender Equity in Agriculture) 2(2+0)

Art, science and business of crop production, basic elements of crop production; factors affecting crop production; history of agricultural development; ancient Indian agriculture in civilization era, chronological agricultural technology development in India; Indian agriculture- balance sheet, liabilities; assets and contrasting trends (DATA); agricultural growth, contrasting food chains, diversity in physiography, soil groups, marine, livestock and water; liabilities: soil factors, weather factors, economic ecology, dry and irrigated agriculture, farming systems approach, farming and farm household concept, value addition, requirements in new technology; women in agriculture: multifaceted roles and tasks, work stress factors, nutritional and rural life standards, role in household design making, drudgery reduction for farm women, women friendly agricultural technology; empowerment of women; group dynamics for farm women, rural women; the nucleus of agricultural extension and training.

AGR-121: Water Management 3(2+1)

Water management: definition and scope; irrigation: definition and objectives, water resources and irrigation development in India; soil moisture measurement; soil moisture constants; water and irrigation requirement, irrigation scheduling, irrigation

water measurement; irrigation methods: surface, subsurface, sprinkler and drip irrigation; irrigation efficiency and water use efficiency; irrigation water quality and its management; water management of different crops (rice, wheat, maize, pulses, oilseeds, sugarcane, potato, fodder and forages); Drainage: definition, importance, types, and management; management of eroded lands

Practical

Determination of bulk density; determination of soil moisture content by gravimetric method, tensiometer, electrical resistance block and neutron moisture meter; determination of field capacity, permanent wilting point and pressure plate membrane apparatus; measurement of irrigation water through flumes and weirs; problems and calculation of irrigation water requirement and water use efficiency; determination of infiltration rate; demonstration of furrow, check basin and basin methods of irrigation; cost estimation of drip and sprinkler irrigation system; determination of water quality parameters (pH, EC, carbonates, bicarbonates, boron , Ca^{++}, K^{+}, $Na^{+}$and Mg ++ ion; ESP and SAR).

AGR-211: Weed Management **3(2+1)**

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; weed biology and ecology, crop weed association, crop weed competition and allelopathy; concepts of weed prevention, control and eradication; methods of weed control: physical, cultural, chemical and biological methods, *integrated* weed management; Herbicides: advantages and limitations of herbicide usage in India, herbicide classification, formulations, methods of application; introduction to adjuvant and their use in herbicides; introduction to selectivity of herbicides; compatibility of herbicides with other agro chemicals; weed management in major field crops, shift of weed flora in cropping systems; aquatic and problematic weeds and their control.

Practical

Identification of weeds; survey of weeds in crop fields and other habitats; preparation of herbarium; calculations on weed control efficiency and weed index; herbicide label information; computation of herbicide doses; study of herbicide application, equipment and calibration; demonstration of methods of herbicide applications; preparation of list of commonly available herbicides; study of phytotoxicity symptoms of herbicides in different crops; biology of nut sedge, bermuda grass, *Parthenium,* wild rice Echinochloa and *Phalaris minor*; economics of weed control practices; and visits of related areas and centre.

AGR-212: Organic Farming **2(1+1)**

Organic farming: concept, objectives, prospect, opportunities and priorities; current status of organic farming in India; potential resources for nutrient supply in organic farming; organic farming in relation to soil health and quality; organic manures, biofertilizers, blue green algae and vermicompost in organic farming; water and weed management in organic agriculture; organic farming in relation to conservation agriculture; organic farming in relation to pests and insect disease management; trade industry and certification in organic farming: certification standards, procedures and regulatory mechanisms in organic agriculture.

Practical

Aerobic and anaerobic method of making compost and vermicompost making; preparation of enriched farm and industrial based compost; efficient use of biofertilizers- technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter, Azospirillum* and PSB cultures in fields; visit to an organic farm- bio dynamic farm; quality standards, inspection, certification and labelling and accreditation procedures for farm organic produce .

AGR-312: Field Crops - I *(Kharif)* **3(2+1)**

Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of *kharif* crops; **Cereals** - rice, maize, sorghum, pearl millet and minor millets; **Pulses**: pigeonpea, mungbean and urdbean; **Oilseeds**: groundnut, sesame and soybean; **Fibre crops**: cotton, jute and sunnhemp; and **Forage crops** : sorghum, maize, cowpea, clusterbean and napier.

Practical

Rice nursery preparation and transplanting/seed bed preparation and sowing of *Kharif* crops; calculations of seed rate; sowing of different crops; effect of seed size on germination and seedling vigour of different crops with special reference to soybean/groundnut; effect of sowing depth on germination of crops; Identification of weeds; top dressing of nitrogen in maize and rice and study of fertilizer experiments on rice, maize, sorghum and millets; study of yield contributing characters, yield calculations, harvesting and yield estimation; study of crop varieties and important agronomic experiments.

AGR-321: Field Crops - *II (Rabi)* **3(2+1)**

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *rabi* crops; **Cereals**: wheat, barley; **Pulses**: chickpea, lentil, peas, french bean; **Oilseeds**: rapeseed and mustard, sunflower, safflower and linseed**; Sugar crops**: sugarcane and sugarbeet; **Medicinal and Aromatic crops**: mentha, Isabgol, poppy; **Commercial crops**: potato and tobacco and **Forage crops**: berseem, lucerne and oat.

Practical

Seed bed preparation and sowing of wheat, sunflower, sugarcane and potato; calculations of seed rate; top dressing of nitrogen in wheat and study of fertilizer experiments on wheat and mustard; identification of weeds in wheat and grain legumes, application of herbicide and study of weed control experiments; morphological characteristics of wheat, sugarcane, chickpea and mustard; yield contributing characters of wheat; yield and quality analysis of sugarcane; crop distribution the state and the region; Important agronomic experiments of *rabi* crops and visit to research stations related to rabi crops, preparation of herbarium of medicinal and aromatic crops.

AGR-322: Farming Systems and Sustainable Agriculture **2 (1+1)**

Farming system: definition, principles and components, Integrated Farming System (IFS)models for wetland, irrigated dryland and dryland situations, agroforestry systems; **Sustainable agriculture**: introduction, definition, goal and concepts, factors affecting ecological balance and ameliorative measures; land degradation and conservation of natural resources, Low External Input Agriculture (LEIA) and High External Input Agriculture (HEIA) ; waste lands and their development.

Practical

Preparation of cropping scheme for irrigated and dryland situations; study of existing farming systems in nearby villages; preparation of integrated farming system model for wetlands and drylands under ecosystem of U.P.; preparation of enriched farm yard manure; preparation of vermicompost; visit to urban waste recycling unit; study of profitable utilization of agricultural wastes; visit to poultry and dairy units to study resource allocation, utilization and economics; visit to degraded lands and waste land utilization programme.

M.Sc. (Ag.) Courses

Core Courses

AGR 501 Modern Concepts is Crop Production 3(3+0)

Theory

UNIT I
Crop growth analysis in relation to environment; agro-ecological zones of India.

UNIT II
Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

UNIT III
Effect of lodging; physiology of crop yield, optimization of plant population and planting geometry in relation to different resources, ideotypes, crop modelling.

UNIT IV
Crop response and production functions; concept of soil plant relations; yield and environmental stress.

UNITV
Integrated farming systems, organic farming, and concept of conservation farming including modern concept of tillage, dry farming, concept of balance nutrition integrated nutrient management; precision agriculture.

AGR 502 Principles and practices of Soil Fertility and Nutrient Management 3(2+1)

Theory

UNIT I
Soil fertility and productivity – factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming – basic concepts and definitions.

UNIT II
Criteria of essentiality of nutrients; Essential plant nutrients – their function, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients, chemistry of waterlogged soil.

UNIT III

Preparation and use of farmyard manure, compost, green manures, vermicompost, bio fertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT IV

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizers use efficiency; nutrient interactions.

UNIT V

Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermincomopost and residue wastes in crop.

Practical

- Calculation of fertilizer use indices
- Determination of soil pH, ECe, organic C, total N, available N, P, K and S in soils
- Determination of total N, P, K and S in plants
- Interpretation of interaction effects and computation of economic and yield optima
- Calculation of fertilizer use idices

AGR 503 Principles and Practices of Weed Management 3(2+1)

Theory

UNIT I

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.

UNIT II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

UNIT III

Herbicide structure – activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicide, myco- herbicide and allelochemicals; Degradation of herbicides in soil and plant.

UNIT IV

Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.

UNIT V

Integrated weed management; cost : benefit analysis of weed management.

Practical

- Weed survey in crops and cropping systems
- Crop-weed competition studies
- Preparation of spray solution of herbicides for high and low-volume sprayers
- Use of various types of spray pumps and nozzles and calculation of swath width
- Economics of weed control

AGR 504 Principles and Practices of Water Management 3(2+1)

Theory

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; micro irrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT IV

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

UNIT V

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practical

- Measurement of soil water potential by using tensiometer, and pressure plate membrane apparatus
- Soil-flow characteristics curves
- Water flow measurements using different devices
- Determination of irrigation requirements
- Calculation of irrigation efficiency

- Determination of infiltration rate
- Determination of saturated/ unsaturated hydraulic conductivity

AGR 505 Agrometeorology and Crop Weather Forecasting 3(2+1)

Theory

UNIT I

Agro meteorology – aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind.

UNIT II

Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, radiation utilization by field crops; photosynthesis and efficiency of radiation utilization by field crops; energy budge of plant canopies; environmental temperature: soil, air and canopy temperature.

UNIT III

Temperature profile in air, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation: measures of atmospheric temperature and relative humidity vapour pressure and their relationships; evapotranspiration and meteorological factors determining evapotranspiration.

UNIT IV

Modification of plant environment: artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation.

UNIT V

Weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture.

Practical

- Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure
- Measurement of solar radiation outside and within plant canopy
- Measurement/estimation of evapo-transpiration by various methods
- Rainfall variability analysis
- Determination of heat-unit requirement for different crops measurement of crop canopy temperature

- Measurement of soil temperatures at different depths
- Visit to solar observatory

AGR 506 Agronomy of Major Cereals and Pulses 3(2+1)

Theory

UNIT I
Rabi cereals – Wheat, Barley, Maize, Winter Maize

UNIT II
Kharif cereals – Rice, Maize, Sorghum, Pearlmillet, Minor Millets

UNIT III
Rabi pulses – Chickpea, Lentil, Fieldpea, Frenchbean

UNIT IV
Kharif pulses – Pigeonpea, Greengram, Blackgram.

Practical
- Phenological studies at different growth stages of crop
- Estimation of crop yield on the basis of yield attributes
- Formulation of cropping schemes for various farm size and calculation of cropping and rotational intensities
- Working out growth indices (CER, CGR, RGR, NAR, LAD), aggressiveness, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems of different crops
- Estimation of protein content in pulses
- Judging of physiological maturity in different crops
- Intercultural operations in different crops
- Determination of cost of cultivation of different crops
- Working out harvest index of various crops
- Study of seed production techniques in various crops

AGR 507 Agronomy of Oilseed, Fibre and Sugar Crops 3(2+1)

Theory
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of :

UNIT I
Kharif oilseeds – Groundnut, Sesame, Castor, Sunflower, Soybean etc.

UNIT II
Rabi oilseeds – Rapeseed and Mustard, Linseed, Safflower etc.

UNIT III
Fiber crops – Cotton, Jute, Sun hemp etc.

UNIT IV
Sugar crops – Sugar- beet and Sugarcane.

Practical

- Determination of sugar crop maturity and calculation on purity percentage, recovery percentage and sucrose content in juice phenological studies at different growth stages of crop
- Intercultural operation in different crops
- Seed treatment & preparation of sugar crop planting material
- Working out growth indices (LER, CGR, RGR, NAR, LAD), aggressively, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping system
- Judging of physiological maturity in different crops and working out harvest index
- Working out cost of cultivation of different crops
- Estimation of crop yield on the basis of yield attributes
- Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities
- Determination of oil content in oilseeds and computation of oil yield
- Estimation of quality of fiber of different crops
- Study of seed production techniques in various crops
- Visit of field experiments on cultural, fertilizer, weed control and water management aspects
- Visit to nearby village for identification of constraints in crop production

AGR 508 Agronomy of Medicinal, Aromatic and Under-Utilized Crops **3(2+1)**

Theory

UNIT I
Importance of medicinal and aromatic plant in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and uses.

UNIT II

Climate and soil requirement; cultural practices; yield and important constituents of medicinal plants (Isabgol, Rauwolfia, Poppy, Aloe vera, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, Nux vomica, Rosadle etc).

UNIT III
Climate and soil requirement; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium etc).

UNIT IV
Climate and soil requirement; cultural practices; yield of under-utilized crops (Rice bean, Lathyrus, *Sesbania*)

Practical

- Identification of crops based on morphological and seed characteristics
- Preparation of herbarium of medicinal, aromatic and under-utilized plants
- Quality characters in medicinal and aromatic plants
- Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants

AGR 509 Agronomy of Fodder and Forage Crops 3(2+1)

Theory

UNIT I
Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crop like maize, bajra, guar, cowpea, oats, barley, sorgum, berseem, senji, lucerne etc.

UNIT II
Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses like, napier grass, Guineagram, Paragrass, Buffelgrass, Deenanath grass

UNIT III
Year-round fodder production and management, preservation and utilization of forage and pasture crops.

UNIT IV
Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition; value addition of poor quality fodder.

UNIT V
Seed production techniques.

Practical

- Crop Cafeteria
- Canopy measurement, yield and quality estimation, viz, crude protein, NDF, ADF, lignin, silica, cellulose etc. of various fodder and forage crops
- Anti-quality components like HCN in sorghum and such factors in other crops
- Hay and silage making and economics of their preparation

AGR 510 Agrostology and Agro-Forestry 3(2+1)

Theory

UNIT I

Agrostrology: definition and importance; principles of grassland ecology: grassland ecology – community, climax, dominant species, succession, biotype, ecological status of grassland in India, grass cover of India; problems and management of grassland.

UNIT II

Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation-natural pastures, cultivated pasture; common pasture grasses.

UNIT III

Agroforestry: definition and importance; agroforestory systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aquasilvicultre, alley cropping and energy plantation.

UNIT IV

Crop production technology in agro-forestry and agrostology system; silvipastoral system: meaning and importance for wasteland development; selection of species, planting methods and problem of seed germination in agro-forestry systems; irrigation and manuring in a agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economics viability, nutritive value of trees; tender operation; desirable tree characteristics.

Practical

- Preparation of charts and maps of India showing different types of pastures and agro-forestry systems
- Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry
- Seed treatment for better germination of farm vegetation
- Methods of propagation/planting of grass and trees in silvipastoral system
- Fertilization application in strip and silvipastroal systems

- After-care of plantaion
- Estimation of protein content in lopping of important fodder trees
- Estimation of calorie value of wood of important fuel trees
- Estimation of total biomass and fuel wood
- Economics of agro-forestry
- Visit to important agro-forestry research stations

AGR 511 Cropping Systems 2(2+0)

Theory

UNIT I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping system; assessment of land use.

UNIT II

Concept of sustainability in cropping systems and farming systems, scope and objectives; crop rotation, production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; factors of sustainability and research need

UNIT IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

AGR 512 Dryland Farming 3(2+1)

Theory

UNIT I

Definition, concept characteristics of dry land and rainfed farming, significance and dimensions of dry land farming in Indian agriculture.

UNIT II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry areas; characterization of environment of water availability.

UNIT III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry areas; types of drought, wild season corrections for aberrant weather conditions, concept of water harvesting, techniques and practices, use of mulchos, kind, affectiveness and economic, anti transpirants.

UNIT IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation; soil and crop management techniques, seeding and efficient fertilizer use.

UNIT V

Concept of watershed resource management, problems, approach and components.

Practical

- Seed treatment, seed germination and crop establishment in relation to soil moisture contents
- Moisture stress effects and recovery behaviour of important crops
- Estimation of moisture index and aridity index
- Spray of anti-transparent and their effect on crops
- Collection and interpretation of data for water balance equations
- Water use efficiency
- Preparation of crop plans for different drought conditions
- Study of field experiments relevant to dry land farming
- Visit to dry land research stations and watershed projects

AGR 513 Principles and Practices of Organic Farming 3(2+1)

Theory

UNIT I

Organic farming- concept and definition, its relevance to India and global agriculture and future prospects; land and water management –land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II

Organic farming and water use efficiency; soil fertility, nutrient recycling organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and bio fertilizers.

UNIT III
Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT IV
Management of weeds, diseases and insect pest management by cultural, biological agents pheromones and bio pesticides.

UNIT V
Socio-economic impacts; marketing and export potential: inspection, certification, labelling and accreditation procedure; organic farming and national economy.

Practical

- Aerobic and anaerobic methods of making compost
- Making of vermicompost
- Efficient use of bio fertilizer, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter, Azospirillum*, and PSB cultures in field
- Visit to an organic farm
- Quality standards, inspection, certification and labelling and accreditation procedures for farm produce from organic farms

AGR 514 Field Experimentation 3(2+1)

UNIT I
Principles of field design, planning, layout and analysis of Completely Randomized design Randomized Complete Block Design and Latin Square design.

UNIT II
Planning and analysis of Factorial experiments, Split plot and Strip Plot design.

UNIT III
Concepts of confounding, complete and partial.

UNIT IV
Interatiions and their significance, production functions and their analyses.

Practical

Layout of different designs in the field. Numericals, calculations; graphical representations of production functions. Field sampling and its analyses.

AGR-515 Management of Problem Soils 3(2+1)

Theory

UNIT I

Origin, nature, properties, area and distribution of saline, sodic, calcareous, acid and waterlogged soils and basic concept of problematic soils, and factors responsible.

UNIT II

Plant response to soil reaction, nutrient imbalance in saline, sodic and saline-sodic, acid and waterlogged soils; tolerance mechanisms.

UNIT III

Extent of damage to crops by saline, acid and waterlogged soils; crop to clearance to salinity, sodicity, acidity and waterlogged.

UNIT IV

Reclamation of problem soils, role of soil amendments and soil drainage; agronomic practices in relation to problem soils, cropping pattern for problem soils.

Practical

- Characterization of salt-affected, calcareous, acid and waterlogged soils.
- Determination of soil pH, EC, CEC,
- Determination of anions (Cl^-, SO_4^-, CO_3^- and HCO_3^-) in soil.
- Determination of cations (Na^+, K^+, Ca^{++} and Mg^{++}) in soil.
- Lime and gypsum requirements of acid and sodic soils.

Visit to problematic areas to acquaint with production contranints.

Ph.D. Courses

AGR 601 Current Trends In Agronomy 3(3+0)

Theory

UNIT I
Agro-physiological basis of variation in yield, recent advances in soil plant water relationship.

UNIT II
Globalization of agriculture and WTO, contract farming, organic farming, marketing and export potential of organic products, certification, labelling and accreditation procedures.

UNIT III
Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy. Optimization and indices for biological efficiency of the system.

UNIT IV
Precision farming; Climate change, GM crops

UNIT V
Concepts of system agriculture; holistic approach of farming systems dryland farming, sustainable agriculture and research methodology in Agronomy.

AGR 602 Crop Ecology 2(2+0)

UNIT I
Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT II
Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT III
Physiological response of crop plants to light, temperature, CO_2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT IV
Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

UNIT V
Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

AGR 603 Crop Production and System Modelling 3(2+1)

Theory
UNIT I
Systems classification; flow charts, modelling techniques and methods of integration-state, rates and driving variables, feedbacks and relational diagrams.

UNIT II
Elementary models for crop growth based on basic methods of classical growth analysis.

UNIT III
Crop modelling methods for crop-weather interaction, climate change and variability components.

UNIT IV
Potential production: leaf and canopy CO_2 assimilation, respiration, dry matter accumulation, crop phonology and dry matter distribution and development in different crops.

UNIT V
Production by moisture availability, potential evapotranspiraion, water balance of the soil, and production with nutrient and moisture limitations.

Practical
- Simulation of elementary models for crop growth
- Simulation of potential production
- Simulation with limitations of water and nutrient management options
- Sensitivity analysis using different climatic years and crop management pactices

AGR 604 Advances in Crop Growth and Productivity 3(2+1)

Theory

UNIT I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; of leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

UNIT II

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated condition; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT III

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

UNIT IV

Concept of plant ideotypes: characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

- Field measurement of root-shoot relationship in crops at different growth stages
- Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc.; at different stages of crop growth
- Computation of harvest index of various crops
- Assessment of crop yield on the basis of yield attributing characters
- Construction of crop growth curves based on growth analysis data
- Computation of competition functions, viz, LER, IER aggressivity competition index etc in intercropping
- Senescence and abscission indices
- Analysis of productivity trend in un-irrigated areas
- Analysis of productivity trend in irrigated areas

AGR 605 Irrigation Management 3(2+1)

Theory

UNIT I

Water resources of India, irrigation project; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT II

Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT III

Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT IV

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT V

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation toirrigation; optimizing the use of given irrigation supplies.

UNIT VI

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Practical

- Determination of water infiltration characteristics and water holding capacity of soil profiles
- Moisture extraction pattern of crops
- Consumptive use, water requirement of a given cropping pattern for optimum/variable productivity
- Crop planning at the farm and project level
- Agronomic evaluation of irrigation projects, case studies

AGR 606 Advances in Weed Management 2(2+0)

Theory

UNIT I
Crop-weed competition in different cropping situations; problematic weed, change in weed flora, various causes and affects.

UNIT II
Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT III
Climate factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT IV
Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

UNIT V
Herbicide development & registration procedures.

UNIT VI
Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides,
Allelochemical herbicide bioassays.

AGR 607 Intergrated Farming System 2(2+0)

Theory

UNIT I
Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

UNIT II
Concept of sustainability in farming systems; efficient farming systems; natural resources – identification and management.

UNIT III

Production potential of different components of farming systems; interaction and mechanism of different production factors including crop-live stock interaction; stability in different systems through research; eco-physiological approaches to intercropping.

UNIT IV
Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.

UNIT V
New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

AGR 608 Soil Conservation and Watershed Management 3(2+1)

Theory

UNIT I
Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

UNIT II
Soil conservation: definition, methods for soil conservation; agronomic measures- contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures – bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

UNIT III
Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

UNIT IV
Land use capability classification, alternate land use systems; agro-forestry; ley farming; jhum management – basic concepts, socio-ethnic aspects, its layout.

UNIT V
Drainage considerations and agronomic management; rehabilitation of abandoned jhum lands and measures to prevent soil erosion.

Practical

- Study of different types of erosion
- Field studies of different soil conservation measures
- Run-off and soil loss measurement
- Laying out run-off plot and deciding treatments
- Identification of different grasses and trees for soil conservation
- Visit to a soil conservation research centre, demonstration and training centre

AGR 609 Strees Crop Production 3(2+1)

Theory

UNIT I
Stress and strain terminology; nature and stress injury and resistance; causes of stress.

UNIT II
Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperatures tress through, soil and crop manipulations.

UNIT III
High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.

UNIT IV
Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations.

UNIT V
Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plant, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations.

UNIT VI
Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance on plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.

UNIT VII
Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.

UNIT VIII

Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

Practical

- Determination of electrical conductivity of plant cell sap
- Determination of osmotic potential and tissue water potential
- Measurement of transpiration rate
- Measurement of stomatal frequency
- Growing of plants in sand culture under salt stress for biochemical and physiological studies
- Studies on effect of osmotic and ionic stress on seed germination and seedling growth

Measurement of low temperature injuries under field conditions

ANIMAL HUSBANDRY AND DAIRYING

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)

B.Sc. (Ag.) Courses

Core Courses

AHD-221	Livestock production & Management	3(2+1)
AHD- 311	Introductory Dairy Sciences :	2(1+1)

M. Sc (Ag.) and Ph.D. IN LIVESTOCK PRODUCTION AND MANAGEMENT COURSE

M. Sc (Ag.) LPM COURSES

LPM 601	CATTLE AND BUFFALO PRODUCTION AND MANAGEMENT	3(2+1)
LPM 602	SHEEP AND GOAT PRODUCTION AND MANAGEMENT	3(2+1)
LPM 603	SWINE PRODUCTION AND MANAGEMENT	2(1+1)
LPM 604	LABORATORY ANIMAL PRODUCTION AND MANAGEMENT	2(1+1)
LPM605	SHELTER MANAGEMENT	2(1+1)
LPM 606	PRINCIPLES OF ENVIRONMENTAL HYGIENE AND WASTE MANAGEMENT	2(2+0)
LPM 607	CLIMATOLOGY AND ANIMAL PRODUCTION	1(1+0)
LPM 608	POULTRY FARM AND HATCHERY MANAGEMENT	3(2+1)
LPM 609	FARM ANIMAL BEHAVIOR	1(1+0)
LPM 610	INTEGRATED LIVESTOCK FARMING SYSTEM	3(2+1)
LPM 611	EQUINE PRODUCTION AND MANAGEMENT	2(1+1)

LPM 612	WILD LIFE MANAGEMENT AND CONSERVATION	2(2+0)
LPM 613	LIVESTOCK BUSINESS MANAGEMENT	2(1+1)
LPM 691	MASTER'S SEMINAR	1(1+0)
LPM 699	MASTER'S RESEARCH	20

Ph.D. LPM COURSES

LPM 701	ADVANCES IN CATTLE AND BUFFALO PRODUCTION AND MANAGEMENT	3(3+0)
LPM 702	ADVANCES IN SHEEP AND GOAT PRODUCTION AND MANAGEMENT	3(2+1)
LPM 703	ADVANCES IN SWINE PRODUCTION AND MANAGEMENT	3(2+1)
LPM 704	ADVANCES IN LABORATORY ANIMAL PRODUCTION AND MANAGEMENT	1(1+0)
LPM 705	ADVANCES IN POULTRY PRODUCTION MANAGEMENT	3(2+1)
LPM 706	ADVANCES IN ENVIRONMENTAL MANAGEMENT	2(1+1)
LPM 707	ADVANCES IN EQUINE MANAGEMENT	2(2+0)
LPM 791	DOCTORAL SEMINAR I	1(1+0)
LPM 792	DOCTORAL SEMINAR II	1(1+0)
LPM 799	DOCTORAL RESEARCH	45

M. Sc and Ph.D. IN DAIRY TECHNOLOGY COURSE

M. Sc (Ag.) DAIRY TECHNOLOGY

DT 511	ADVANCED DAIRY PROCESSING	4(3+1)
DT 512*	ADVANCED FOOD PROCESSING	4(3+1)
DT 513	RHEOLOGY OF DAIRY AND FOOD PRODUCTS	3(2+1)
DT 514	DAIRY PROCESS BIOTECHNOLOGY	3(2+1)

DT 515	TRADITIONAL AND VALUE-ADDED DAIRY PRODUCTS	3(2+1)
DT 521	MEMBRANE TECHNOLOGY IN DAIRY PROCESSING	3(2+1)
DT 522	ADVANCED DAIRY AND FOOD PACKAGING	3(2+1)
DT 523	ALTERNATIVE PROCESSES FOR THE DAIRY & FOOD INDUSTRIES	3(2+1)
DT 524	FUNCTIONAL FOODS AND NEW PRODUCT DEVELOPMENT	4(3+1)
DT 525	TECHNOLOGY OF FOOD EMULSIONS, FOAMS & GELS	3(2+1)
DT 591	MASTER'S SEMINAR	1(1+0)
DT 599	MASTER'S RESEARCH	20

Ph.D. DAIRY TECHNOLOGY

DT 611	ADVANCES IN LIPID TECHNOLOGY	3(3+0)
DT 612	ADVANCES IN PROTEIN TECHNOLOGY	3(3+0)
DT 621	PRODUCT MONITORING AND PROCESS CONTROL	3(3+0)
DT 622#	R & D MANAGEMENT IN DAIRY INDUSTRY	3(3+0)
DT 691	DOCTORAL SEMINAR I	1(1+0)
DT 692	DOCTORAL SEMINAR II	1(1+0)
DT 699	DOCTORAL RESEARCH	45

B.Sc. (Ag.) Courses

AHD- 221 Livestock Production and Management 3 (2+1)

Significances of livestock in relation to agriculture and National economy. Breeds of various classes of livestock and birds , their classification , origin distribution and body characteristics. External anatomy of cattle, buffalo, goat, sheep and fowl. Methods of handling and restraint for different kinds of farm animals. The livestock industry, its scope and potential. Inheritance of livestock traits – Knowledge of breeding system and selection of animals, Artificial Insemination. Physiological mechanism of livestock production –Reproduction, digestion, lactation, growth & egg production. Nutrition & livestock production –General nutrition, consideration & meeting nutrient needs of various classes of livestock. Livestock Management – Management of cattle, swine, goat, sheep & poultry. Etiology of common diseases &their preventive measures.

Practicals:

External body parts of cow, buffalo and birds. Approaching and handling of different species of livestock , casting of cattle , restraining small animals. Methods of marking animals. Dentition and aging of animals. Judging of livestock and poultry. Determination of body weight & age of animals Observation and signs of heat, pregnancy and calving Disbudding, dehorning and castration, Milking and milk recording, Familarity with A. I. System, Identification of feeds, Computation of ration for cattle, Maintenance of farm records, Cleaning of cattle sheds, Symptoms of health and diseases

AHD-311 Introductory Dairy Science 3 (2+1)

Definition and general composition of milk from different species. Outline, composition and physical structure of milk constituents. Colustrum and its properties, correlations amongst compositional parameters, legal standards of milk, chemical tests, stability for milk quality. Plateform tests and sediment test. Physicochemical properties of milk. Adulteration in milk and their detection. Coagulation and heat stability of milk. Elementary knowledge about indigenous & modern dairy products.

Practicals:

Sampling of milk. Test for fat in milk by Gerber and babcock methods. Testing for total solids and solids-not-fat in milk. Plateform tests. Measurement of physicochemical properties of milk- specific gravity, boiling and freezing point, pH and acidity. Detection of various adulterants in milk.

M. Sc (Ag.) IN LIVESTOCK PRODUCTION AND MANAGEMENT COURSE

LPM 601 Cattle and Buffalo Production and Management 3(2+1)

Theory

UNIT I

Introduction – Development of Dairy Industry in India and world – Present status and future prospects of livestock development in India

UNIT II

Important breeds of cattle and buffalo, traits of economic importance and their inter relationships - Selection of high quality animals - Role of management in improving the reproduction efficiency in farm animals. - Housing and rearing systems.

UNIT III

Breeding Management: System of breeding Economic traits. Methods of Breeding - Prenatal and postnatal care and management of cattle and buffalo - Care of neonate and young calves - Management strategies for reducing mortality in calves, age at first calving and calving interval in cattle and buffaloes.

UNIT IV

Management of labour, Milking management, Machine milking and hand milking, Different laws governing the livestock sectors to produce quality products on par with international standards - Technique of harvesting clean and hygienic livestock products, transportation of animals, health management. Wallowing in buffaloes- Management of draught animals and summer management

UNIT V

Feed and fodder resources used for feeding of cattle and buffaloes– Scientific technique of feeding, watering – Computation of practical and economical ration, supply of green fodder around the year and enrichment of poor quality roughages.

Practical

Visits to cattle farms and critical analysis of various types of managerial practices - Study of breeding management in the farm- Analysis of practical feeding management- Disease control- Housing – milking - calf, heifer and adult management- Dairy Cattle and Buffalo judging - Project preparation for external funding and commercial farms and enterprises for dairy products – marketing strategies for milk and milk products and meat.

LPM 602 Sheep and Goat Production and Management 3(2+1)

Theory

UNIT I

Introduction - Population structure and importance- Advantages and disadvantages of sheep farming under different systems of management – type of housing and equipments- Important sheep and goat breeds- Advantages and disadvantages of sheep and goat farming.

UNIT II

Breeding Management: Breeding seasons - fitness of purchase for first breeding - methods of detection of heat - Natural Service and artificial insemination - Care of the pregnant Animals - Breeding stock - Use of teaser - Culling.

UNIT III

Feeding Management: Feeding methods - Principles to be followed in feeding and watering- feeder space, waterer space, Designing feeders and waterers. - Range management - Stocking rate and pasture improvement and utilization; management under stall fed conditions, Transportation of sheep and goat.

UNIT IV

Disease Management: Role of management in the prevention and control of diseases. Special Management: Deworming - Dipping and spraying- shearing - Avoidance of goatry odour in milk, Tipping.

UNIT V

Wool: Importance of wool - Fiber structure- Fleece characters - Goat fibers - Characters of mohair and pashmina, fur and Angora - Marketing of goat fibers / wool.- Planning of sheep and goat farm of various sizes - Economics of sheep and goat farming.

Practical

Visit to sheep and goat farms and critical analysis of various managerial practices under different conditions. Study of practical housing management - Analysis of practical diseases control management - Shearing management - Record keeping. - Preparation of project for commercial farming - Characterization of sheep and goats; handling of sheep and goat; daily and periodical operations for sheep and goats - Methods of identification of sheep and goat. Cost of rearing sheep and goat for mutton and wool - Housing plans for various age and categories of sheep and goat - Dipping; Vaccination of sheep and goat - Shearing of wool.

LPM 603 Swine Production and Management 2(1+1)

Theory

UNIT I

Introduction - Population and importance - Economic contribution of pigs - Advantages and disadvantages of swine keeping - Systems of management - Problems in pig farming.

UNIT II

Breeds of pigs - Selection of breeding stock - Breeding seasons - Age and weight at first services - Methods for detection of heat – Natural service and artificial insemination - Care of pregnant sows, piglets and growers - Care of breeding boar.

UNIT III

Housing, sanitation and hygiene, disease prevention measures - Housing and equipment –Wallowing - Sanitation and hygiene - Role of management in the prevention and the control of diseases.

UNIT IV

Feeding and management of new born, weaner and finishers, dry, pregnant and farrowing sows - Feeding principles to be followed - Methods of watering – Feeder space – Waterer space, etc - Marketing: Methods of marketing in swine production - Record keeping.

Practical

Visits to piggeries and critical Analysis of various types of managerial practices - Analysis of the trend and structures of pig population - Analysis of practical breeding management methods, practical disease control management - special management methods - Ageing and identification – Judging - Constraints and remedial measures in pig farming - Economics of production - Project preparation for research and commercial farms.

LPM 604 Laboratoray Animal Production and Management 2(1+1)

Theory

UNIT I

Introduction - Importance of rabbit for meat and fur production, rats, mice and guinea pigs, - Common breeds and strains.

UNIT II

System of housing – Common diseases and their control measure.
Management of specific pathogen free and gnotobiotic animals, concepts to related to welfare of laboratory animals

UNIT III

Breeding - Age at maturity, litter size - Weaning – Feeding of growers – Selection of replacement stock, transportation of rabbit.

UNIT IV

Transportation of Laboratory animals – marketing of meat and fur.

Practical

Handling and restraining of laboratory animals - Visits to small animal farms and critical analysis of various types of managerial practices- Analysis of the trend and structures of Laboratory animals population - Analysis of practical breeding management methods - practical disease control management and special management methods - Ageing and identification – Judging - Economics of production.

LPM 605 Shelter Management 2(1+1)

Theory

UNIT I

General principles in planning animal houses- farmstead and animal houses - Selection of site and planning; layouts for livestock farm of different sizes in different climatic zones in India - Farm structures - General principles of construction of enclosures, floor and road.

UNIT II

Housing requirements of different classes of Livestock - Preparation of layouts, plans, arrangement of alleys- Fitting and facilities in the houses for horses, dairy cattle, calves, bulls, work cattle, dogs, pigs, sheep, goats, and poultry.

UNIT III

Improvement of existing buildings; water supply; feed and fodder delivery systems - Economics of Livestock housing.

UNIT IV

Housing - Disease control measures and sanitation of all classes of livestock

Practical

Score card for animal houses - Time and motion study in Animal houses - Preparation of plans for Animal houses for horses, cattle, sheep, pigs, goats, and other livestock - Dogs and other pet animals - Economics of livestock housing - Preparation of plan for animal houses of different sizes and climatic zones of India.

LPM 606 Principles of Environmental Hygiene and Waste Management 2(2+0)

Theory

UNIT I

Animal air hygiene: Definition - Composition of air - Air pollution – Factors affecting outdoor and indoor pollution - Assessment of these factors on animal health and production - Methods to control these factors.

UNIT II

Water Hygiene: Importance of water - Impurities and inclusions – Sterilization - Examination of water and water supplies - Collection of samples- Topographical physical, chemical, bacteriological and microscopic examination of water - Hygienic requirements and standards for drinking water - Quantity of water required by domestic animals - Methods of watering.

UNIT III

Manure - Quantity of manure voided by domestic animals - Animal excreta a factor in spread of disease - Hygienic and economic disposal of farm waste - Modern techniques used in automation / semi-automation in disposal of farm waste.

UNIT IV

Environmental protection act, Air (Prevention and control of pollution) act and water (Prevention and control of pollution) act - Biosecurity measures to be adapted for efficient and healthy production

UNIT V

Effect of environmental pollution on livestock and its products directly and indirectly - Controlling environmental pollution - Different factors affecting the quality of livestock and its products meant for human consumption.

LPM 607 Climatology and Animal Production 1(1+0)

Theory

UNIT I

Definition of climate -Classification of climatic regions - Climatic factors- Assessment of climate - Study of climatic factors in relation to animal production.

UNIT II

Light, natural and artificial light-mechanism of light action-photo period and light responses – Applications - Importance of light in production of animals and birds.

UNIT III

Introduction of breeds into different climatic regions - Agro meteorology and weather forecasting for Animal Husbandry activities - Micro climate modification in animal houses.

UNIT IV

Estimation of microclimatic conditions in Animal house - Measurement of Temperature, Relative humidity, Air Velocity and Mean temperature of the surrounding, measurement of intensity of light in animal houses – Construction of climographs and hythergraphs -Estimation of cooling power of atmosphere heat tolerance test in bovines.

LPM 608 POULTRY FARM AND HATCHERY MANAGEMENT 3(2+1)

Theory

UNIT I

Poultry housing systems Cage Vs floor system, litter management and lights for poultry, rearing turkey, duck and quails.

UNIT II

Management of chicks, growing, laying and breeding flocks, broiler production, selection and culling of laying flocks.

UNIT III

Procuring, care and pre-incubation storage of hatching eggs - Method of incubation, sanitation disinfection and management of hatchery.

UNIT IV

Embryonic development and factors effecting fertility and hatchability of eggs.

UNIT V

Chick sexing, packing and hatchery business - Transporting management of farm and hatchery waste.

Practical

Poultry Farm management - Brooding of chicks; selection of laying flocks - Disease preventive measures - Selection and care of hatching eggs; incubator operation, fumigation and candling setting and hatching, packaging of chicks - Waste management - Marketing of products.

LPM 609 Farm Animal Behaviour 1(1+0)

Theory

UNIT I

Introduction to Animal behaviour - Importance of animal behaviour studies - Patterns of behaviour - Daily and seasonal cycles of behaviour – Physiological basis of behaviour.

UNIT II

Environmental modification of behaviour - Developmental changes in behaviour - Genetic differences in behaviour - Behavioural disorders.

UNIT III

Group formation - Social relationship, process of socialisation locality and behaviour - Practical application - Behavioural character for managemental practices - Favourable and unfavourable behaviour for domestication - Behavioural adaptations under domestication.

UNIT IV

Physical environment and behaviour - Common vices and their remedial measures - Analysis of behaviour in relation to location - Analysis of behaviour in relation to climatic environment - Analysis of social behaviour.

LPM 610 Integrated Livestock Farming System 3(2+1)

Theory

UNIT I

Scope and limitation of integrated farming systems - Sustainability of integrated Livestock Farming Systems and their economic importance.

UNIT II

Integration of fish, arable farming and different livestock enterprises vis-à-vis gobar gas plant, FYM, solar and wind energy utilization, cattle, buffalo sheep, goat, pig, poultry, rabbit, silk worm, bee keeping etc.

UNIT III

New approach for changing farming systems in present energy crises.

UNIT IV

Project formulation and evaluation of various livestock enterprises.

Practical

Various livestock farming units and their economic analysis - Evaluation of different farming systems and their economic importance – Preparing feasibility report for various farming projects.

LPM 611 EQUINE PRODUCTION AND MANAGEMENT 2(1+1)

Theory

UNIT I
Equine population in India - Breeds of native and exotic horses - Types and classes of light and work horses.

UNIT II
Housing and routine management practices –Hygiene and maintenance of stable. Color and markings, Dentition and ageing selecting and judging horses- unsoundness and stable vices

UNIT III
Feeding and breeding of horses donkey and Mules, foaling, care of foal

UNIT IV
Foot care and shoeing care, Stud farms - Race clubs - Race horses and their care - Horse behaviour and training - Exercising - Basic Horsemanship

UNIT V
Health management & diseases control. Control of internal and external parasites of horse- Colic and its prevention

UNIT VI
Mode of transport - Facilities requirement - Cleaning, disinfection and preparation of vehicles Transport stress - Management during transport - Regulatory acts of states and centre in animal disease control and welfare. Precautions and requirements before, during and after transport – Laws governing the import and export of livestock and its products- - Horse passport and trading.

Practical

Control of horse for examination, passing of stomach tube, dentition and ageing, saddling, exercising of horse, hoof care**.**

Pilliner S. 1994. *Care of the competition Horse*. BT Batsford.

Rose RJ & Hodgson DR. 2000. *Manual of Equine Practice*. WB Saunders.

LPM 612 Wild Life Management and Conservation 2(2+0)

Theory

UNIT I

Zoo and captive wild animals - Principles and concepts – Ecology of wild life sanctuaries and National parks- wild life legislation in India - Status of forest in India - Biological and ecological basis of management of wild life.

UNIT II

Voluntary organization on wild life - Rules and regulations of zoo authority of India -Wild life protection act - Zoological classification of wild animals - Funding agencies for wild life research and preparation of project. - Conservation of wild animals.

UNIT III

Wild life health control - Reproduction in zoos - Population analysis - Population manipulation - Habit analysis and design - The resources and its management - Distribution of important Indian animals - Zoo animals and birds - Breeding characteristics – Movements - Cover requirements - Food - Population density – Mortality - Nesting losses caused by predators, predator and prey relationship - Human interference - Refuge rehabilitation

UNIT IV

Restraints - Maps - Survey and plans of management systems - Principles, protective measures - Development and conservation of water supply- puberty - Breeding seasons - pregnancy - Parturition - Lactation postnatal survival of the young - Social factors among various species - Miscellaneous management procedures.

LPM 613 Livestock Business Management 2(1+1)

Theory

UNIT I

Management principles - Planning - Techniques, strategic planning, organization structure, co-ordination and controlling techniques – Approaches to management.

UNIT II

SWOT analysis, financial accounting - Accounting records - Balance sheet, fund flow statement - Cost and analysis for managerial decisions – Budgeting and control .

UNIT III

Tools of financial analysis, working capital financing - Long term financial management - Investment analysis - Capital markets - Corporate risk management - Venture capital.

UNIT IV

Marketing - Objectives, strategies - Selecting and managing marketing channels - Pricing strategies - Sales promotion - Legislation relating licensing - Company law.

Practical

Preparation of financial statements, depreciation accounting methods, trend and variance analysis, cost-volume profit analysis - Financial planning and forecasting - Estimation of working capital requirement - Break even analysis - Visit to livestock business firms and banks - Preparing projects for financing.

Ph.D. IN LIVESTOCK PRODUCTION AND MANAGEMENT COURSE

LPM 701 Advances in Cattle and Buffalo Production and Management 3(3+0)

Theory

UNIT I
Dairy farming in India – Global scenario - Present status and reasons for the same – Avenues for progress – The needs of the nation and how to achieve it.

UNIT II
Advances in housing management of dairy cattle and buffaloes in various agroclimatic zone of India - Management systems for cattle and buffaloes.

UNIT III
Establishing Dairy Cattle Enterprise – Characteristics of a successful dairy farm – Choice of the foundation stock – Breeding Management Problems associated with reproduction.

UNIT IV
Advances in Feeding Management of cattle and buffalo, Feed for milking herd, dry cows, bulls and calves, Management of high yielding animals.

UNIT V
Milking Management – Biosynthesis of milk - Factors affecting the composition and yield of milk - milk ejection reflex - Milking systems – Sanitary standards for the f quality milk – Cessation of milking, advances in herd management- raising calves – growing heifers, replacements and culling – marketing, Computerization of dairy enterprises.

UNIT VI
Advance in health management of dairy animals, metabolic diseases of high yielders- advances in preventive measures for production related diseases

LPM 702 Advances in Sheep and Goat Production and Management 3(2+1)

Theory
UNIT I Utility origin – Domestication - Numbers and distribution of meat and dual purpose breeds - Methods of rearing – Range sheep production.

UNIT II

The farm flock – Pure bred flock - Management during breeding season – The sexual seasons and its control - Puberty – Time of the year to breed – Flushing – Ram-Ewe ratio.

UNIT III

Advances in feeding management, Nutrient deficiencies in range forage, Feed to supplement range forage,General feeding practices, Feeding materials, Lamb feeding, Use of antibiotics and hormones, Hand feeding, Self feeding, Pellet feeding , Feeding lambs and ewes during lactation.

UNIT IV

Recent development in sheep and goat management and their relevance under Indian economic conditions, needs and possibilities for future research.

UNIT V

Role of sheep husbandry in dry farming in India, Present development programmes in sheep and goat production, Adances in reproduction, housing, feeding and watering, diseases, Shearing methods and culling of sheep and goat. Role of goat in animal agriculture, Goat farming in India, selection of Breeding stock, Breeding problems, Housing, Principles of feeding, Practices,Crops and crop residues for goats, Milking practices.

Practical

Study of population trend and structure - Visit to sheep and goat farms and critical analysis of various farm practices, Analysis of breeding, feeding, housing - Disease control management, management of young ones and maturing systems Estimation of fibre diameter medullation percentage crimps, tensile strength, Grease, pH and moisture content of wool - Score card and grading of wool.

LPM 703 Advances in Swine Production and Management 3(2+1)

Theory

UNIT I

The past, present and future of Swine production systems in India and production policies adopted in advanced countries.

UNIT II

Advances in breeding and selection – Prenatal and postnatal development - Growth reproduction and lactation - Economic traits of swine production.

UNIT III

Advances in feeding and nutrition in pigs; automatic feeding and watering techniques, Feed stuffs, Energy, protein, minerals and vitamin sources, metabolic and nutritional disorders – Toxic substances.

UNIT IV

Advances in housing of pigs, environmental physiology - Infectious diseases and parasitism. reduction in new born piglet mortality.

Practical

Marketing - Study of population trend and structure. Analysis of breeding, feeding, housing, health care, farrowing management, summer management and special management principles practiced.

LPM 704 Advances in Laboratory Animal Production and Management 1(1+0)

Theory

UNIT I

Importance and limitations of rabbits for meat and fur production, rats, mice & guinea pigs - Common breeds and strains.

UNIT II

Advances in system of housing, Common diseases and their control measure.

UNIT III

Breeding strategies - Age at maturity, litter size, Weaning, Feeding of growers, Selection of replacement stock, transportation of rabbit.

UNIT IV

Transportation of Laboratory animals – marketing of meat and fur.

UNIT V

Management of specific pathogen free and gnotobiotic animals ,concepts to related to welfare of laboratory animals

Practical

Visit to Rabbit farms - Study of the various chores in government farms and private farms - Critical analysis of breeding, feeding, disease control management and housing - Rabbit slaughter technique.

LPM 705 Advances in Poultry Production Management 3(2+1)

Theory

UNIT I

Planning, organisation, executive and management of poultry farms and hatcheries of various sizes - alternative in poultry production.

UNIT II

Demand, supply, present status of poultry production.

UNIT III

Problems and new management techniques in poultry for egg and meat in India vis-à-vis in other countries of the world, automation in poultry houses, management of specific pathogen free flocks.

UNIT IV

Poultry development policies and planning for higher production constraints in development and solutions, ethnology and entology in relation to poultry production

Practical

Planning and preparation of research and commercial projects on broiler and layer production management.

LPM 706 Advances in Environmental Management 2(1+1)

Theory

UNIT I

The animal Industry and the quality of the environment – Management of the living environment - Microenvironment and macro environment.

UNIT II

Air Pollution: Indoor and outdoor - Chemical, physical and bacteriological changes - Causes – Standards and the extent tolerated by animals - Effects on animal production.

UNIT III

Fixing standards in relation to CO_2 - Air supply in relation to cubic space, temperature, air, velocity, relative humidity, dust particles, bacterial count, effective temperature and cooling power - Methods to get over pollution – Cleaning and washing - Air conditioning.

UNIT IV

Utilisation and disposal of animal waste,Health hazards, Waste utilization, technologies for processing and treatment of animal wastes, Health and economic impacts, Legal constraints, Microbiology of wastes, Waste properties ,Gases and odour.

UNIT V

Water Pollution: Significance, treatment and control - Funding agencies for animal welfare

Practical

Assessment of various factors in Indoor and outdoor environment- Assessment of CO_2, air supply, dust particles and bacterial count in air - Visit to sewage treatment plant - Planning farm waste disposals - Physical chemical and bacteriological examination of water watering of farm animals.

LPM 707 ADVANCES IN EQUINE MANAGEMENT 2(2+0)

Theory

UNIT I

New indigenous and exotic horses breeds- Types and classes of light and work horses

UNIT II

Advances in housing and routine management practices –Hygiene and maintenance of stable. Color and markings, Dentition and ageing selecting and judging horses- unsoundness and stable vices

UNIT III

New Feeding techniques and breeding of horses donkey and Mules, foaling, care of foal

UNIT IV

Foot care and shoeing care, Stud farms,Race clubs,Race horses and their care, Horse behaviour and training, Exercising ,Basic Horsemanship

UNIT V

Advances in health management & diseases control. Control of internal and external parasites of horse- Colic and its prevention

UNIT VI

Mode of transport, Facilities requirement, Cleaning, disinfection and preparation of vehicles Transport stress,Management during transport, Regulatory acts of states and centre in animal disease control and welfare. Precautions and requirements before, during and after transport, Laws governing the import and export of livestock and its products, Horse passport and trading.

M. Sc (Ag.)

DAIRY TECHNOLOGY

DT 511 Advanced Dairy Processing 4(3+1)

Theory

UNIT I

Use of bio-protective factors for preservation of raw milk: effects on physicochemical, microbial and nutritional properties of milk and milk products, present status of preservation of raw milk by chemical preservatives; thermal processing for preservation.

UNIT II

Methods of determining lethality of thermal processing, UHT processed milk products, their properties and prospects, types of UHT plants, aseptic fillers, heat stability and deposit formation aspects, effect on milk quality;techno- economic considerations; retort processing.

UNIT III

Principles and equipment for bactofugation and Bactotherm processes, Microfluidization of milk: Principle, equipment, effects and applications, Homogenization and their applications in dairy industry.

UNIT IV

Dehydration: advances in drying of milk and milk products; freeze concentration, freeze dehydration: physicochemical changes during freeze drying and industrial developments.

UNIT V

Water activity; sorption behaviour of foods, energy of binding water, control of water activity of different milk products in relation to their chemical; microbiological and textural properties; hurdle technology and its application in development of shelf-stable and intermediate-moisture foods, Use of carbonation in extending the shelf life of dairy products.

UNIT VICurrent trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio-detergents, development of sanitizers- heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

Practical

LP system for extension of keeping quality raw milk, determination of pH; HCT profile of milk systems, measurement of thiocyanate in milk system; determination of water activity and sorption isotherms of milk products; determination of thermal load during retort processing of milk and milk products; heat classification of milk powders; functional properties of powders: porosity, interstitial air content, occluded air content, flowability; determination of degree of browning- hemical/physical methods; freeze drying of milk/milk products, and heat sensitive products. Homogenization efficiency; cleaning efficiency in dairy equipment; visit to a UHT Processing plant. Thermal process calculations.

DT 512 Advanced Food Processing 4(3+1)

Theory

UNIT I

Status of food processing industry in India and abroad; prospects and constraints in development of Indian food industry.

UNIT II

Post harvest management of fruits and vegetables, Harvesting indices, Biochemical and physical changes during ripening of fruits & vegetables, respiration and factors affecting it, role of ethylene in accelerated ripening, post harvest treatments for extension of shelf-life of fresh produce, Strategic interventions to minimize post harvest losses including vapour heat treatment, wax coating, chemicals, etc.

UNIT III

Principles of chilling & refrigeration storage of foods, quality changes in cold stored products, controlled and modified atmospheric storage. Freezing of foods, principle and equipments for freezing, defects in frozen foods, re-crystallization, freezing of fruits and vegetables, freeze concentration of fruit juices.

UNIT IV

Application of heat energy to foods for preservation and processing, concept of drying rate of foods, industrial drying processes of foods; changes during drying, advanced drying processes (Freeze drying, infra red drying and

microwave drying), Canning of fruits & vegetables, unit processes involved in canning, types of cans for thermal processing of foods.

UNIT V

Basic principles involved in fermentation, Technological aspects of pickled vegetables like sauerkraut, cucumbers, Technology of wine, beer and distilled alcoholic beverages, defects in alcoholic beverages. Conversion of muscle into meat, rigor mortis, freezing and canning of meat, curing & smoking of meat, fermented sausages, cooking of poultry, utilization of milk ingredients in processed meat and poultry products.

UNIT VII

Advances in milling of rice (solvent extractive milling) and Turbo milling of wheat. Bakery products; role of ingredients, Developments in manufacturing processes for bakery products such as breads; biscuits; pizza bases, cake etc; changes during processing of bakery products. Utilization and importance of dairy ingredients in bakery products.

UNIT VIII

Definition, classification and technologies of fabricated and formulated foods and their nutritional aspects. Imitation dairy products and dairy analogues. Principle of extrusion processing, design and working of extruder, classification, application in food and dairy processing. Food additives, including stabilizers, emulsifiers, antioxidants, preservatives, etc.
for formulated foods.

UNIT IX

Important group of enzymes involved in food processing; Application of enzymes in food processes like enzymes juice extraction, juice clarification, in bread manufacture, meat tenderization, ice cream manufacture, desugaring of egg, etc.

UNIT X

Newer concepts in food processing including organic foods, processing of organic raw material, genetically modified foods.

Practical

MAP and its effect on shelf-life of fresh fruits and vegetables, Preparation of squash, cordial, nectar and whey beverages, whey based soups, Manufacture of bread, pizza base, biscuits and cake, Application of milk ingredients in caramel, egg-less cake, mayonnaise, canning of fruits & vegetables, manufacture of chicken soup, comminuted meat products, enzymatic extraction and clarification of fruit juices, Preparation of soymilk and tofu, Drying of fruits & vegetables, efficacy of blanching treatment. Manufacture of sauerkraut/fermented vegetables.

DT 513 Rheology of Dairy & Food Products 3(2+1)

Theory

UNIT I

Introduction to rheology of foods: Definition of 'texture', 'rheology' and 'psychophysics' – their structural basis; physical considerations in study of foods; salient definitions –Stress tensor and different kinds of stresses.

UNIT II

Rheological classification of Fluid Foods : Shear-rate dependence and time dependence of the flow-curve; Non-Newtonian fluids; thixotropy; Mechanisms and relevant models for non-Newtonian flow; Effect of temperature; Compositional factors affecting flow behaviour; Viscosity of food dispersions – dilute and semi-dilute systems, concentration effects.

UNIT III

Comparative assessment of different types of Viscometers, and their Merits and Limitations: Co-axial cylinders, Spindle- or Impeller-type viscometers, Cone-plate viscometer, Capillary viscometers, Falling-sphere viscometer, Vibratory viscometers, Extrusion viscometer, Orifice viscometer.

UNIT IV

Rheology of semi-solid and solid food ; Rheological characterization of foods in terms of stress-strain relationship; Viscoelasticity; Transient tests - Creep Compliance and Stress Relaxation; mechanical models for viscoelastic foods: Maxwell, Kelvin, Burgers and generalized models and their application; Dynamic measurement of viscoelasticity.

UNIT V

Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.

UNIT VI

Rheological and textural properties of selected dairy products: Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data.

Practical

Study of different types of viscometers viz., co-axial cylinder viscometer, spindle viscometer, falling-ball viscometer, extrusion viscometer, impeller viscometer, orifice viscometer; Flow behaviour of fluid dairy products; Thixotropy in ice-cream mix; force-deformation study in selected dairy products using Texture Analyzer; Back extrusion; Effect of test conditions on the texture profile parameters of cheese and similar products; stress relaxation studies in solid foods; Use of Cone Penetrometer and FIRANIRD extruder for measurement of butter texture; Use of a Viscoamylograph for study on the gelatinization behaviour of starch/cereals flours.

DT 514 DAIRY PROCESS BIOTECHNOLOGY 3(2+1)

Theory

UNIT I

Definition of biotechnology; development and impact of biotechnology on food and dairy industry.

UNIT II

Microbial rennet and recombinant chymosin, characteristics and application in cheese making; exogenous free and microencapsulated enzymes, immobilized enzymes-their application in accelerated ripening of cheese; enzymatically modified cheeses (EMC) their utilization in various food formulations.

UNIT 3

Technological requirements of modified micro-organisms for production of cheese and fermented milk products; technological innovations in the development of functional dairy foods with improved nutritional therapeutic and pro-biotic attributes; physiologically active bio-peptides/ nutraceuticals; protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, pro-biotic cheese and fermented milks; bifidus factors in infant food formulations.

UNIT IV

Protein hydrolysates-production, their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages.

UNIT V

Microbial polysaccharides their properties and applications in foods, production of alcoholic beverages and industrial products from starch; whey and other by-products; bio-sweeteners-types properties and their applications in dairy and food industry.

UNIT VI

Bio-preservatives- characteristics and their application in enhancing the shelf life of dairy and food products.

Practical

Effect of exogenous enzymes on hydrolysis of protein and fat in culture containing milk systems; to study the various factors affecting the coagulation of milk by microbial rennets. Manufacture and evaluation of pro-biotic cheese and fermented milks; determination of glycolysis, proteolysis and lipolysis in cheese and fermented milk; enzymatic process
for manufacture of low lactose milk whey products; preparation of casein hydrolysates; visit to a bio-processing unit.

DT 515 Traditional and Value Added Products 3(2+1)

Theory

UNIT I

Present status of traditional dairy products; globalization of traditional dairy products; plans and policies of the Government and developmental agencies.

UNIT II

Process schedule of heat-desiccated, coagulated and fermented traditional dairy products; process improvement in production of milk sweets.

UNIT III

New products based on fruits, vegetables and cereals; application of membrane technology; microwave heating for industrial production of traditional dairy products.

UNIT IV

Advances in industrial production of ghee, flavour and texture simulation.

UNIT V

Techno-economic aspects for establishing commercial units for traditional products.

UNIT VI
Convenience traditional dairy products; use of natural and permitted synthetic preservatives and new packaging systems.

Practical

Microwave heating of traditional milk delicacies for shelf life extension; application of membrane technology for improving the quality of traditional products from cow and buffalo milk; preparation of feasibility report for establishing commercial units for traditional products.

DT 521 Membrane Technology in Dairy Processing 3(2+1)

Theory

UNIT I
Membrane techniques: classification and characteristics of filtration processes; types of membranes commercially available; membrane hardware, design of membrane plants, modeling of ultrafiltration (UF) processes, mass transfer model, resistance model; membrane flouling-problem and treatment, cleaning and sanitization of different types of membranes.

UNIT II
Factors affecting permeate flux during ultrafiltration and reverse osmosis of milk and sweet and sour whey, energy requirements for processing of milk and whey.

UNIT III
Applications of ultrafiltration, reverse osmosis, nanofiltration and microfiltration in the dairy industry. Developments in the manufacture and utilization of food and pharmaceutical grade lactose from UF permeate. Preparation of special foods like low lactose powder and dairy whiteners using UF retentate, whey protein concentrates, casein and coprecipitates.

UNIT IV
Demineralisation: Importance of demineralisation, different processes available for demineralization: their principle, plant and operation.

UNIT V
Functional properties of whey proteins (WPC & WPI), casein, coprecipitates and UF milk retentate and their modifications. Evaluation of functional properties of proteins.

Practical

Study of the effect of types of milk, temperature of milk and transmembrane pressure on the permeate flux during ultrafiltration process; performance of ultrafiltration membrane with respect to permeate flux and volume concentration ratio during processing of acid and sweet whey; study the effect of types of milk, temperature and applied pressure on the permeate flux during the reverse osmosis process; nanofiltration of milk, whey and permeate; microfiltration of skim milk and whey; preparation of whey protein concentrate and its utilization in dairy products; measurement of different functional properties of casein and whey protein: whipping ability; water binding; emulsification properties; gelling; viscosity and solubility.

DT 522 Advanced Dairy and Food Packaging 3(2+1)

Theory

UNIT I
Status of current packaging; types of packaging materials; criteria for selection of proper packaging; testing of packaging materials.

UNIT II
Adhesives; graphics; coding, and labeling used in food packaging.

UNIT III
Protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture; active packaging; special problems in canned foods.

UNIT IV
Packaging of dairy products; packaging of convenience foods, packaging of fruits, vegetables, and fruit juices.

UNIT V
Packaging of fats and oils; packaging of spices; packaging of meat and poultry: packaging of fish and other seafoods.

UNIT VI
Modified atmosphere packaging, controlled atmosphere packaging, shrink and stretch packaging.

UNIT VII
Retort pouch technology, microwavable, biodegradable, and edible packages.

UNIT VIII

Industrial packaging: unitizing, palletizing, containerising, distribution systems for packaged foods including prevention of shock damage to articles during transportation.

UNIT IX

Safety aspects of packaging materials; sources of toxic materials and migration of toxins into food materials.

Practical

Testing of packaging materials for quality assurance like determination of thickness, GSM, grease resistance, bursting strength, tearing resistance, WVTR, puncture resistance; estimation of shelf life of vegetables and seasonal fresh fruits; packaging of turmeric powder and ground red chilli powder, vacuum packaging of dairy products.

DT 523 ALTERNATIVE PROCESSES FOR DAIRY AND FOOD INDUSTRY 3(2+1)

Theory

UNIT I

Irradiation: sources and properties of ionizing radiation; mechanism of interaction with microorganisms and food components microbial inactivation in dairy and food products, chemical effects, packaging, industrial irradiation systems, benefits and limitations; safety aspects, national and international regulations.

UNIT II

High frequency heating: Principles of dielectric heating and factors affecting it, design and working of microwave oven, continuous microwave heating units, applications in dairy and food processing, microwavable packaging safety aspects of microwaves, merits and demerits of dielectric heating.

UNIT III

Infra-red heating: Interaction of infra-red (IR) radiation with penetration properties, equipment; dairy and food application, advantages and disadvantages of IR heating.

UNIT IV

Ohmic heating: Principle of electric resistance heating, design of an ohmic heater, operational variables, power considerations, factors affecting heating efficiency, merits and limitations, food applications and future scope.

UNIT V

Ultrasonic treatment of food: Mechanism of ultrasound induced cell damage, generation of ultrasound equipment, design of power ultrasonic system, types of ultrasonic reactors, application of power ultrasound in food processing,

effects on food constituents, ultrasound in consideration with other process alternatives - thermosonication, advantages and future prospects.

UNIT VI
High hydrostatic pressure processing: Principle of microbial inactivation, barotolerance of microorganisms, effect on food constituents, equipment, dairy and food application, merit and demerits.

UNIT VII
Pulsed electric field processing: Description/ mechanism and factors affecting microbial inactivation effects on food components; present status and future scope for food applications.

Practical
Study of a microwave oven; Determination of power output of a microwave oven; Temperature profile in a microwave oven cavity; Microwave absorption by various food packaging materials; Heating behaviour of water, milk, cream and other milk products – effect of composition; Shelf-life extension of pasteurized milk employing microwave heating; Effect of shape and size of water/milk container on microwave heating; Cooking of 'instant' products in a microwave oven; Drying of casein, 'instant' wheat, 'instant' rice, etc. in a microwave oven; Miscellaneous food processing/heating applications of microwaves; Visit
to a commercial food irradiation facility.

DT 524 FUNCTIONAL FOODS AND NEW PRODUCT DEVELOPMENT 4(3+1)

Theory

UNIT I
Definition, classes of functional foods, status of functional foods in world and India. Concept of new product development, classes of nutraceuticals and functional foods. Safety; marketing strategy and consumer response; economic analysis and costing of novel foods, recent advances in different categories and type of dairy product.

UNIT II
Nutritional status and dietary requirement of different target group and deficiency diseases, in special reference to micronutrients. Dietary and therapeutic significance of dairy nutrients, bioactive components in dairy products like lactose, whey proteins, milk minerals, CLA, fermented milks etc.

UNIT III
Food fortification, techniques for fortifying dairy foods with minerals and vitamins, High protein foods prospective nutraceuticals for fortification of dairy foods. Nutritional significance of dietary fibers, classes of dietary fibers, fortification techniques for fibers in dairy foods.

UNIT IV

Infant nutrition and dietary formulations for meeting normal and special needs of infants, current status of infant foods, additives for infant foods. Foods for aged persons, design consideration, ingredients for geriatric foods.

UNIT V

Technological aspects of reduced calorie foods, alternatives for calorie reduction, low calorie sweeteners, bulking agents and their application, fat replacers and their utilization in low calorie dairy foods.

UNIT VI

Nutritional and health significance of sodium in foods, Alternatives for sodium in foods, techniques for reducing sodium in processed dairy foods. Bio-flavours and flavour enhancers.

UNIT VII

Sports foods, ingredients for sports foods, dairy components in sports foods, sports drinks, design consideration, ergogenic aids in sports nutrition.

UNIT VIII

Herbs, various classes of herbs, their therapeutic potential and application in foods with special reference to dairy products like functional drinks, herbal ghee etc.

UNIT IX

Prebiotic substances and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and synbiotics.

UNIT X

Definition and various classes of phytochemicals, their role in CVD, Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulphur compounds, flavonoids, carotenoids, etc.

UNIT XI

Special foods/nutrients for CVD, cancer, IBD, diabetics, persons suffering 21 with milk allergy and lactose intolerance with special emphasis on dairy nutrients and foods.

Practical

Determination of total fiber, neutral detergent fiber in foods; manufacture of fiber enriched milk beverage; manufacture of low calorie burfi/ice cream; preparation of flavoured milk using artificial sweetener and its estimation; determination of antioxidant activity of food/food components; determination of bioavailability of

nutrients; development of malted milk food and weaning food; determination of β-galactosidase activity and application of lactases for lactose free dairy products determination of prebiotic potential of certain plant/milk components and their application in synbiotics dairy foods preparation of sports beverage, herbal dairy drinks; preparation of high protein products.

DT 525 Technology of Food Emulsions, Foams and Gels 3(2+1)

Theory

UNIT I
Food dispersions, their characteristics and factors affecting food dispersions.

UNIT II
Food emulsions; emulsifiers and their functions in foods; the HLB concept in food emulsifiers; emulsion formation and stability; polymers and surfactants.

UNIT III
Milk foams and their applications, structure of foams, egg foams and uses, foam formation and stability.

UNIT IV
Theory of gel formation; pectic substances and jellies; fruit pectin gels; milk jellies.

UNIT V
Structure of dairy foods representing emulsions, foams and gels; physical structure of fat rich, concentrated, fermented, coagulated and dried products.

UNIT VI
Techniques for evaluation of structure for food emulsions, foams and gels.

Practical

Determination of the rate of formation and stability of emulsions; Emulsifying properties of milk proteins and other food ingredients; Properties of different types of emulsifiers and their role in food emulsions; Examination of foam formation and determination of foam stability; Milk proteins and other food ingredients in food foams; foaming in dairy systems; Studies on gel formation and gel properties; Food gels – Gelatinbased, pectin-based, etc.; Properties of various gelling agents for foods.

DT 611 Advances in Lipid Technology 3(3+0)

Theory

UNIT I

Current Trends in the fats & oil Industry in India and abroad: Sources and utilization of animal, vegetable and marine fats/oils - An overview.

UNIT II

Basic chemistry structure aspects of fats and oils in general, and milk-fat in particular, in relation to their processing, properties, utilization and significance in human diet.

UNIT III

The changing concepts in the role of edible fats and oils in human nutrition and health: PUFA, MUFA, CLA, Omega fatty acids, Trans fatty acids, Phytosterol, etc.

UNIT IV

Sources and classification of commercial edible fats and oils : Innovations in the production and processing of oils and fats from different sources, e.g. animal, plant, marine and microbial lipids for utilization in the dairy and food products; Non-conventional fats/oils for edible purpose – rice bran oil, microbial lipids.

UNIT V

Advances in refining including degumming, bleaching and deodorization oils and fats – Existing technologies and new developments - application of membrane techniques; Winterization.

UNIT VI

Physico-chemical properties of oils & fats; Polymorphism, crystallization kinetics; New antioxidants.

UNIT VII

Modification of fats and oils: Physical modification – Fractionation; Chemical modification – Hydrogenation and Interesterification; enzymatic/microbial modification of fats/oils; Cholesterol reducing treatments.

UNIT VIII

Applications of fats and oils: Margarine and low-fat table spreads; Bakery and confectionery fats; Coatings; Shortenings; Salad dressings; Technology of cooking oils, salad oils and oil based dressings; Frying process and systems; Changes in fats and oils during frying; Snack foods – Processing systems; Modified fats and oils for use in bakery and confectionery products, shortenings and spreads.

UNIT IX

Fat replacers, technological developments in low calories spreads and other fat-based products.

UNIT X

Advances in technologies for production of plasticisers, emulsifiers and protective coatings.

DT 612 Advances in Protein Technology 3(3+0)

Theory

UNIT I
Characteristics of proteins from plant, animal and microbial origins.

UNIT II
Denaturation of proteins: Effect of processing parameters on denaturation. Effect of denaturation on the physicochemical and biological properties of proteins in food systems.

UNIT III
Protein interactions with food constituents: protein-protein interactions. Protein-lipid interactions, protein-polysaccharide interactions, and proteinion interactions. Significance of protein interactions: formation and stabilization of casein micelle, stability of concentrated milk products, and role of protein in food structure.

UNIT IV
Protein Nutrition: Recent concepts in protein nutrition in man: Enzyme development and protein digestion. Effect of processing on nutritive value of proteins. Mass and institutional feeding programs: Amino acid fortification of foods and concepts in protein supplementation and complementation.

UNIT V
Protein hydrolysates-- Production and processing; De-bittering of protein products; Bioactive peptides: their production and properties.

UNIT VI
Recent Technologies: Augmentation of world resources for protein foods: protein from plants, animals and microorganisms.

UNIT VII
Textured vegetable proteins and spun fibre technology: Extrusion cooking selection of ingredients and formulation, control of operational parameters, microstructure of extrusion cooked foods.

DT 621 Product Monitoring and Process Control 3(3+0)

Theory

UNIT I

The concept of Product-Process Monitoring in dairy and food industries: Definition of 'quality'; Optimization paradigm; Quality-prediction model based on quality kinetics and process state equations – Simulation modeling. Process/Product Optimization: Optimization procedures – Search methods, Response surface, Differentiation & Programming methods; Neural Networks; Optimization software.

UNIT II

Process Control: Objectives; Control loop – Loop elements and their functions; Modes of process control; Control techniques; control equipment.

UNIT III

Real-time Instrumentation : Sensors; their classification based on Proximity, working principle; examples of applications in process control; Requirements of on-line sensors; Biosensors – Construction, types, working principles, applications, merits and limitations; Time-temperature indicators – partial-history & full-history indicators; Commercial devices; Applications and limitations; E-Nose & E-Tongue – Simulation of natural organs; Components & their functions; Applications.

UNIT IV

Flavour analysis: Flavour bioassays – Gas Chromatography-Olfactometry techniques; Isolation, Separation and detection/Identification of flavour compounds – GC-MS, LC-MS, NMR, FTIR; analysis of chiral compounds.

UNIT V

Formation of flavour compounds in milk and milk products during heat processing (including UHT processing, caramelization and extrusion cooking), fermentation and ripening (cultured. products and cheese flavour, with special reference to bitteness) and storage (Maillard browning); Aroma losses/retention during the drying process (in relation to milk powder, cheese powder and dry cultured products); Industrial processes for extraction of desirable and undesirable volatile components from fresh and/or stored products by supercritical fluid (SCF) technique.

UNIT VI

Monitoring of Food Structure: (a) Application of Thermal Analysis (DTA and DSC vis-a-vis dilatometry) and Pulse Nuclear Magnetic Resonance (PNMR) spectroscopy in determination of solid-fat content (SFC) of butter in relation to various processing and storage aspects; Glass transitions in dairy products; Starch gelatinization.

UNIT VII

Monitoring of Food Structure: (b) Elucidation of crystal characteristics of milk fat in ghee and other fat-rich products by means of X-ray Crystallography with reference to the impact of cooling and storage/handling conditions on the crystal nature and product texture; Process-induced changes in sub-microscopic particulate properties of milk products; structure-texture relationship.

UNIT VIII

Monitoring of Food Structure: (c) Influence of heat processing and freezing treatments on protein denaturation and other conformational as well as aggregation-disaggregation phenomena as monitored through Spectropolarimetry, Circular Dichroism and related techniques.

UNIT IX

Monitoring of Food Structure: (d) Particle-size analysis: Image analysis; Dynamic light scattering; Laser diffraction; Sieving, and other techniques.

UNIT X

Emerging Spectroscopic techniques in assessment of foods : Raman Spectroscopy and Electron Spin Spectroscopy – Working principles and applications - Monitoring of irradiated foods, detection of lipid autooxidation, etc.; Microwave & NIR absorption/reflection methods for Compositional analyses – Automated milk analysers; Proximate principles in cheese and milk powder.

UNIT XI

Ultrasound in product monitoring: Speed- and Attenuation-based measurements of liquid levels, density, mass flow, etc.

UNIT XII

Monitoring of Chemical Contaminants: Heavy metal quantification by Atomic Absorption Spectrophotometer; Quantification of Agrochemicals by HPLC; Spectrofluorimetric determination of mycotoxins; Detection and quantification of Drug Residues.

UNIT XIII

Colour Characterization : Colour and appearance (gloss and translucence) monitoring through visual colorimeter, tri-stimulus colorimeters and reflectance spectrophotometer, CIE, Hunter-Lab, Munsel and other systems of three-dimensional expression of colour; Colour-based Sorting of foods; Computer Vision – Principles, applications and Benefits.

UNIT XIV

Objective Assessment of Subjective food-quality characteristics – Pitfalls and Promises.

DT 622 Research & Development Management in Dairy Industry 3(3+0)

Theory

UNIT I

Current Status of R&D Efforts in Dairy Processing in India and abroad.

UNIT II

Resource Management: Management of financial and human resources in dairy Industry: a) Structure and design of Research and Development orgnisation; b) Analysis of organization behaviour – Transactional analysis; and c) Personnel management – Typology analysis, individual and the organization, team building, human behaviour at work, motivation.

UNIT III

Management of R&D functions: a) Criterion for the selection of R&D projects; Technology Development Process and b) Techniques for monitoring R & D functions.

UNIT IV

Patenting Laws; Indian Patenting Act/International Protocols for technology transfer; Transfer of technology from Lab to Plant, HACCP, GMP/GHP practices in dairy processing. ISO14001, Total Quality Management (TQM), Six-Sigma concept.

UNIT V

Project proposal writing for research funding, Development of feasibility and technical report for dairy plant establishment, evaluation and report writing of projects.

ENTOMOLOGY & AGRIL. ZOOLOGY

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)
B.Sc. (Ag.) Courses		
Core Courses		
EAZ – 211	Insect Morphology and Systematics	3(2+1)
EAZ – 221	Insect Ecology and Integrated Pest Management Including Beneficial Insects	3(2+1)
EAZ – 311	Crop Pests and Stored Grain Pests and Their Management	3(2+1)
EAZ – 312	Introductory Nematology	2(1+1)
M.Sc. (Ag.)		
Non Credit Compulsory Courses		
PGS 501	LIBRARY AND INFORMATION SERVICES	1(0+1)
PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	1(0+1)
PGS 503	INTELLECTUAL PROPERTY AND THEIR APPLICATION IN AGRICULTURE (e-Course)	1(1+0)
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	1(0+1)
PGS 505	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (e-Course)	1(1+0)
PGS 506	DISASTER MANAGEMENT	1(1+0)

Course Structure

ENT 501*	INSECT MORPHOLOGY	2(1+1)
ENT 502*	INSECT ANATOMY, PHYSIOLOGY AND NUTRITION	3(2+1)
ENT 503	PRINCIPLES OF TAXONOMY	2(2+0)
ENT 504*	CLASSIFICATION OF INSECTS	3(2+1)
ENT 505*	INSECT ECOLOGY	2(1+1)
ENT 506	INSECT PATHOLOGY	2(1+1)
ENT 507*	BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS	2(1+1)
ENT 508*	TOXICOLOGY OF INSECTICIDES	3(2+1)
ENT 509	PLANT RESISTANCE TO INSECTS	2(1+1)
ENT 510*	PRINCIPLES OF INTEGRATED PEST MANAGEMENT	2(1+1)
ENT 511*#	PESTS OF FIELD CROPS	2(1+1)
ENT 512*#	PESTS OF HORTICULTURAL AND PLANTATION CROPS	2(1+1)
ENT 513	STORAGE ENTOMOLOGY	2(1+1)
ENT 514	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS 1+1	
ENT 515	GENERAL ACAROLOGY	2(1+1)
ENT 516	SOIL ARTHROPODS AND THEIR MANAGEMENT	2(1+1)
ENT 517	VERTEBRATE PEST MANAGEMENT	2(1+1)
ENT 518*	TECHNIQUES IN PLANT PROTECTION	1(1+0)
ENT 519	COMMERCIAL ENTOMOLOGY	2(1+1)
ENT 520	PLANT QUARANTINE	2(2+0)
ENT 591	MASTER'S SEMINAR	1(1+0)

ENT 599	MASTER'S RESEARCH	20

Ph.D. Courses

ENT 601	ADVANCED INSECT SYSTEMATICS	3(1+2)
ENT 602	IMMATURE STAGES OF INSECTS	2(1+1)
ENT 603	ADVANCED INSECT PHYSIOLOGY	2(2+0)
ENT 604	ADVANCED INSECT ECOLOGY	2(1+1)
ENT 605	INSECT BEHAVIOUR	2(1+1)
ENT 606	RECENT TRENDS IN BIOLOGICAL CONTROL	2(1+1)
ENT 607	ADVANCED INSECTICIDE TOXICOLOGY	3(2+1)
ENT 608	ADVANCED HOST PLANT RESISTANCE	2(1+1)
ENT 609	ADVANCED ACAROLOGY	2(1+1)
ENT 610	AGRICULTURAL ORNITHOLOGY	2(1+1)
ENT 611**	MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH	2(1+1)
ENT 612**	ADVANCED INTEGRATED PEST MANAGEMENT	2(2+0)
ENT 613/	PLANT BIOSECURITY AND BIOSAFETY	2(2+0)
PL PATH 606/ ENT 691	DOCTORAL SEMINAR - I	1(1+0)
ENT 692	DOCTORAL SEMINAR - II	1(1+0)
ENT 699	DOCTORAL RESEARCH	45

B.Sc. (Ag.) Courses

EAZ – 211. Insect Morphology and Systematics 3(2+1)

History of Entomology in India. Factors for insects abundance. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts and legs. Wing venation, modifications and wing coupling apparatus. Structure male and female genetalia. Sensory organs. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system in insects. Types of reproduction in insects. Systematics: Taxonomy – importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders. Orthoptera, Acrididae. Dictyoptera, Mantidae, Odonata, Isoptera, Termitidae, Thysanoptera, Thripidae, Hemiptera, Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae, Neuroptera, Chrysopidae Lepidoptera, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Coleoptera, Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae, Hymenoptera, Tenthridinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae, Diptera, Cecidomyiidae, Trypetidae, Tachinidae, Agromyziidae.

Practical: Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus Types of insect larvae and pupae; Dissection of digestive system in insects (Grassopher); Dissection of male and female reproductive systems in insects (Grassopher); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importances.

EAZ – 221 Insect Ecology and Integrated Pest Management Including Beneficial Insects 3 (2+1)

Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors–temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance. Concepts of Balance of life in nature, biotic potential and environmental resistance and causes for outbreak of pests in agro-ecosystem. Pest surveillance and pest forecasting. Categories of pests. IPM; Introduction, importance, concepts principles and tools of IPM-Host plant resistance, Cultural, Mechanical, Physical, Legislative, Biological (parasites, predators & transgenic plant pathogens such as bacteria, fungi and viruses) methods of control. Chemical control – importance, hazards and limitations. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Study of important insecticides. Botanical insecticides – neem based products, Cyclodiens, Organophosphates, Carbamates, Synthetic pyrethroids, Novel insecticides, Pheromones, Nicotinyl insecticides, Chitin synthesis inhibitors, Phenyl pyrazoles, Avermectins, Macrocyclic lactones, Oxadiazimes, Thiourea derivaties, pyridine azomethines, pyrroles, etc. Nematicides, Rodenticides, Acaricides and fumigants. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation and genetic control. Practices, scope and limitations of IPM. Insecticides Act 1968 – Important provisions. Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes. Beneficial insects: parasites and predators used in pest control and their mass multiplication techniques. Important groups of microorganisms, bacteria, viruses

and fungi used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers, their importance. Vermiculture.

Practical: Visit to meteorological observatory / automatic weather reporting station; Study of terrestrial and pond ecosystems of insects; Studies on behaviour of insects and orientation (repellency, stimulation, deterancy); Study of distribution patterns of insects, sampling techniques for the estimation of insect population and damage; Pest surveillance through light traps, pheromone traps and field incidence; Practicable IPM practices, Mechanical and physical methods; Practicable IPM practices, Cultural and biological methods; Chemical control, Insecticides and their formulations; Calculation of doses/concentrations of insecticides; Compatibility of pesticides and Phytotoxicity of insecticides; Identification of earthworms in vermiculture – visit to vermiculture unit; Other beneficial insects – Pollinators, weed killers and scavengers.

EAZ – 311. Crop Pests and Stored Grain Pests and Their Management 3(2+1)

Stored grain pests: Coleopteran and Lepidopteran pests, their biology and damage, preventive and curative methods. Distribution, biology, nature and symptoms of damage, and management strategies of insect and non insect pests of rice, sorghum, maize, ragi (*Eleucine coracana*), wheat, sugarcane, cotton, mesta, sunhemp, pulses, groundnut, castor, gingelly, safflower, sunflower, mustard, brinjal, bhendi, tomato, cruciferous and cucurbitaceous vegetables, potato, sweet potato, colacasia, moringa, amaranthus, chillies, mango, citrus, grapevine, cashew, banana, pomegranate, guava, sapota, ber, apple, coconut, tobacco, coffee, tea, turmeric, betelvine, onion, coriander, garlic, curry leaf, pepper, ginger and ornamental plants.

Practical: Identification of pests, their damage symptoms and management of rice, sorghum, maize, wheat, sugarcane, cotton, pulses, Solanaceous and Malvaceous vegetables, cruciferous and cucurbitaceous vegetables, chilli, mango, carbon, citrus and sapota. IPM case studies; Identification of common phytophagous mites and their morphological characters; Identification of rodents and bird pests and their damage.

EAZ – 312. Introductory Nematology 2 (1+1)

Introduction: History of phytonematology. Economic importance. General characteristics of plant pathogenic nematodes. Nematode general morphology and biology. Classification of nematodes upto family level with emphasis on groups containing economically important genera. Classification of nematodes by habitat. Identification of economically important plant nematodes upto generic level with the help of keys and description. Symptoms caused by nematodes with examples. Interaction between plant parasitic nematodes and disease causing fungi, bacteria and viruses. Different methods of nematode management. Cultural methods (crop rotation, fallowing, soil amendments, other land management techniques), physical methods (soil solarisation, hot water treatment) Biological methods, Chemical methods (fumigants, non fumigants). Resistant varieties. Integrated Nematode Management.

Practical: Methods of survey – sampling methods, collection of soil and plant samples; Extraction of nematodes from soil and plant tissues following combined Cobb's decanting – sieving and Baermann funnel technique, counting and estimation of plant parasitic nematodes; Preparation of temporary and permanent mounts; Method of preparation of perineal patterns for identification of species of *Meloidogyne*; Study and identification of most important plant parasitic nematodes with special

reference to their characteristics and symptomtolgy – *Meloidogyne, Pratylenchus; Heterodera, Ditylenchus, Globodera, Tylenchulus, Xiphinema, Radopholus, Rotylenchulus*, and *Helicotylenchus*. Experimental techniques used in pathogenicity studies with root knot nematode.

M.Sc. (Ag.) Courses

PGS -501 Library and Information Services 1(0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, web of Science search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI

Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

PGS -502 Technical Writing and Communications Skills 1(0+1)

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination,

Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;

Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout

Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National

Biological Diversity Act, 2003.

PGS- 503 Intellectual Property and Its Management in Agriculture (E-COURSE) 1(1+0)

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge,

trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives;

Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

PGS -504 Basic Concepts in Laboratory Techniques 1(0+1)

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of

solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

PGS -505 Agricultural Research, Research Ethics and Rural Development Programmes (e-Course) 1(1+0)

Theory

UNIT- I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities

at national and regional levels; International fellowships for scientific mobility.

UNIT- II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT- III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural

PGS 506 Disaster Management (e-Course) 1(1+0)

Theory

UNIT -I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT -II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT -III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Core Courses

ENT 501 Insect Morphology 2(1+1)

Theory

UNIT- I

Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.

UNIT -II

Head- Origin, **s**tructure and modification; types of mouthparts and antennae, tentorium and neck sclerites.

UNIT -III

Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications.

UNIT- IV

Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors).

Practical

Study of insect segmentation, various tagmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.

ENT 502 Insect Anatomy, Physiology and Nutrition 3(2+1)

Theory

UNIT- I

Scope and importance of insect anatomy and physiology.

UNIT -II

Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.

UNIT- III

Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause.

UNIT- IV

Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

Practical

Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; chromatographic analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; determination of respiratory quotient; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

ENT 503 Principles of Taxonomy 2(2+0)

Theory

UNIT- I

Introduction to history and principles of systematics and importance. Levels and functions of systematics. Identification, purpose, methodscharactermatrix, taxonomic keys. Descriptions- subjects of descriptions,characters, nature of characters, analogy vs homology, parallel vs convergent evolution, intraspecific variation in characters, polythetic andpolymorphic taxa, sexual dimorphism.

UNIT- II

Classification of animals: Schools of classification- Phenetics, Cladistics and Evolutionary classification. Components of Biological Classification: Hierarchy, Rank, Category and Taxon. Species concepts, cryptic, sibling and etho-species, infra-specific categories. Introduction to numerical, biological and cytogenetical taxonomy.

UNIT -III

Nomenclature: Common vs Scientific names. International Code of Zoological Nomenclature, criteria for availability of names, validity of names. Categories of names under consideration of ICZN. Publications, Principles of priority, and homonymy, synonymy, type concept in zoological nomenclature. Speciation, anagenesis vs cladogenesis, allopatric, sympatric and parapatric processes.

ENT 504 Classification of Insects 3(2+1)

Theory

UNIT- I

Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained.

UNIT- II

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

UNIT -III

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

Practical

Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

ENT 505 Insect Ecology 2(1+1)

Objective

To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, organization of communities, diversity indicies. Train students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

Theory

UNIT -I

History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.

UNIT -II

Basic concepts of abundance- Model vs Real world. Population growthbasic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population

dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.

UNIT -III

Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of nicheecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

UNIT- IV

Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology.

Practical

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

ENT 506 Insect Pathology 2(1+1)

Theory

UNIT- I

History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT- II

Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

UNIT -III

Examples of successful instances of exploitation of pathogens for pest management and mass production techniques of pathogens. Safety and egistration of microbial pesticides. Use of insect pathogens in integrated management of insect pests.

Practical

Familiarization with equipment used in insect pathology laboratory. Identification of different groups of insect pathogens and symptoms of infection. Isolation, culturing and testing pathogenicity of different groups of pathogens. Testing Koch's postulates. Estimation of pathogen load. Extraction of pathogens from live organisms and soil. Bioassays to determine median lethal doses.

ENT 507 Biological Control of Crop Pests and Weeds 2(1+1)

Theory

UNIT -I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation

UNIT -II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects.

UNIT -III

Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.

UNIT - IV

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

ENT 508 Toxicology of Insecticides 3(2+1)

Theory

UNIT- I

Definition and scope of insecticide toxicology; history of chemical control;

pesticide use and pesticide industry in India.

UNIT -II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.

UNIT- III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

UNIT -IV

Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

UNIT -V

Insecticide residues, their significance and environmental implications Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Practical

Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices.

ENT 509 Plant Resistance to Insects 2(1+1)

Theory

UNIT-I

History and importance of resistance, principles, classification, components, types and mechanisms of resistance.

UNIT -II

Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT -III

Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

UNIT -IV

Factors affecting plant resistance including biotypes and measures to combat them.

UNIT- V

Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

UNIT -VI

Role of biotechnology in plant resistance to insects.

Practical

Screening techniques for measuring resistance; measurement of plant characters and working out their correlations with plant resistance; testing of resistance in important crops; bioassay of plant extracts of susceptible/resistant varieties; demonstration of antibiosis, tolerance and antixenosis.

ENT 510 Principles of Integrated Pest Management 2(1+1)

Theory

UNIT -I

History and origin, definition and evolution of various related terminologies.

UNIT- II

Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.

UNIT- III

Tools of pest management and their integration- legislative, cultural, Physical, mechanical chemical and biological methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

Practical

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessmentdirect losses, indirect losses, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system.

ENT 511 Pests of Field Crops 2(1+1)

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.

UNIT- I

Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.).

UNIT -II

Insect pests of pulses, tobacco, oilseeds and their management.

UNIT -III

Insect pests of fibre crops, forages, sugarcane and their management.

Practical

Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

ENT 512 Pests of Horticultural and Plantation Crops 2(1+1)

Theory

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

UNIT- I

Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits.

UNIT -II

Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, French beans, chow-chow, brinjal, okra, all gourds, gherkin, drumstick, leafy vegetables etc.

UNIT- III

Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc.

UNIT- IV

Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation.

Practical

Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non-insect pests.

ENT 513 Storage Entomology 2(1+1)

Theory

UNIT- I

Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses *in toto visà - vis* total production of food grains in India. Scientific and socio-economic factors responsible for grain losses.

UNIT- II

Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

UNIT- III

Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

UNIT -IV

Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control-

prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

Practical

Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of insect infestation in stored food grains; estimation of losses in stored food grains; determination of moisture content in stored food grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, Hapur etc. (only where logistically feasible).

ENT 514 Insect Vectors of Plant Viruses and Other Pathogens 2(1+1)

Theory

UNIT -I

History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

UNIT -II

Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

UNIT -III

Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

UNIT -IV

Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

UNIT- V

Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

Practical

Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies.

ENT 515 General Acarology 2(1+1)

Theory

UNIT -I

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites.

UNIT- II

Introduction to morphology and biology of mites and ticks. Broad classification- major orders and important families of Acari including diagnostic characteristics.

UNIT -III

Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees. Management of mites using acaricides, phytoseiid predators, fungal pathogens *etc*. Culturing of phytophagous, parasitic and predatory mites.

Practical

Collection of mites from plants, soil and animals; extraction of mites from soil, plants and stored products; preparation of mounting media and slide mounts; external morphology of mites; identification of mites up to family level using keys; studying different rearing techniques for mites.

ENT 516 Soil Arthropods and Their Management 2(1+1)

Theory

UNIT- I

Soil arthropods and their classification, habitats and their identification.

UNIT -II

Estimation of populations; sampling and extraction methods.

UNIT -III

Role of soil arthropods in detritus feeding, litter breakdown and humus formation. Soil arthropods as bio-indicators of habitat qualities. Effect of soil arthropod activity on soil properties.

UNIT -IV

Harmful and beneficial soil arthropods and their management, interrelationship among arthropods and other soil invertebrates and soil microorganisms. Anthropogenic effects on soil arthropods.

Practical

Sampling, extraction methods and identification of various types of soil fauna; estimation and assessment of soil arthropod population; techniques and culturing soil invertebrates.

ENT 517 Vertebrate Pest Management 2(1+1)

Theory

UNIT -I

Vertebrate pests of different crops; biology of vertebrate pests such as rodents, birds and other mammals. Biology of beneficial birds.

UNIT -II

Population dynamics and assessment, patterns of pest damage and assessment, roosting and nesting systems in birds.

UNIT -III

Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites), cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods- Operational practices- baiting, bioassays (LD_{50} studies), equipments and educative programmes.

Practical

Identification of important rodent and other vertebrate pests of agriculture, food preference and hoarding, social behaviour, damage assessment, field survey, population estimation, control operation and preventive methods.

ENT 518 Techniques In Plant Protection 1(1+0)

Theory

UNIT -I

Pest control equipments, principles, operation, maintenance, selection, application of pesticides and biocontrol agents, seed dressing, soaking, root-dip treatment, dusting, spraying, application through irrigation water.

UNIT -II

Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers.

UNIT -III

Use of light, transmission and scanning electron microscopy.

UNIT- IV

Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.

UNIT -V

Use of tissue culture techniques in plant protection. Computer application for predicting/ forecasting pest attack and identification.

ENT 519 Commercial Entomology 2(1+1)

Theory

UNIT -I

Bee keeping- General colony management during different seasons. Seasonal management. Managing colonies for honey production and pollination. Artificial queen rearing. Pests and diseases of honey bees. Bee poisoning. Production and marketing of quality honey and value added honey products. Establishment and maintenance of apiaries.

UNIT -II

Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests and diseases of silkworms, rearing and management of silkworms. Lac insect- natural enemies and their management.

UNIT -III

Economic and public health importance of insect pests in human habitation and habitats, biology, damage and control of mosquitoes, houseflies, bed bugs, ants, termites, cockroaches, flies, silverfish, head and body lice, carpet beetles, cloth moths, crickets, wasps, house dust mites, insect pests of cattle, poultry, pet animals and their management.

UNIT -IV

Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, pre- and postconstruction termite proofing of buildings, appliances for domestic pest control. Rodent control methods. Organic methods of domestic pest management.

Practical

Assessing pest status in dwellings (labs, canteen or hostel), implementation of pest control against flies, mosquitoes, bed bugs, cockroaches and rodents. Pre- and post-construction termite proofing methods, control of silverfishes in the library. Visit to poultry units and assessing pest status in poultries. Evaluation of commercially available domestic insect pest control products through bioassays. Identification of honey bee species, bee castes and special adaptations, identification and handling of bee-

keeping equipments. Handling of honey bees-hive and frame inspection. Honey extraction and processing methods of hive products extraction. Preparation of bee-keeping projects for funding. Visit to bee nursery and commercial apiaries. Silkworm rearing and management. Lac host and crop management technology and processing of lac. Products and bye-products of lac.

ENT 520 Plant Quarantine 2(2+0)

Objective

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up.

Theory

UNIT -I

Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

UNIT -II

Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial

registration; APEDA, Import and Export of bio-control agents.

UNIT -III

Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

UNIT -IV

WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Ph.D. Courses

ENT 601 Advanced Insect Systematics 3(1+2)

Theory

UNIT -I

Detailed study of three schools of classification- numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation processes and evidences. Zoogeography.

UNIT -II

Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

UNIT -III

Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.

UNIT -IV

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, revisionary works, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species.

Practical

Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, construction of taxonomic keys for the selected group. Development of descriptions, photographing, writing diagrams, and preparation of specimens for "type like" preservation. Submission of the collections made of the group. Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarisation for developing cladograms and use of computer programmes to develop cladograms.

ENT 602 Immature Stages of Insects 2(1+1)

Theory

UNIT -I

Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects

UNIT -II

Comparative study of life history strategies in hemi-metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest anagement.

Practical

Types of immature stages; their collection, rearing and preservation. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.

ENT 603 Advanced Insect Physiology 2(2+0)

Theory

UNIT -I

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

UNIT -II

Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

UNIT -III

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

UNIT- IV

Endocrine system and insect hormones, physiology of insect growth and development- metamorphosis, polyphenism and diapause. Energetics of muscle contractions.

ENT 604 Advanced Insect Ecology 2(1+1)

Theory

UNIT -I

Characterisation of distribution of insects- Indices of Dispersion, Taylor's Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-Prey Models- Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.

UNIT -II

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of Associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of Insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic

interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Host seeking behaviour of parasitoids. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses.

UNIT -III

Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.

UNIT- IV

Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies - timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems – Characterisation, Pest Control as applied ecology- case studies.

Practical

Methods of data collection under field conditions. Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc. Calculation of sample sizes by different methods. Fitting Poisson and Negative Binomial distributions and working out the data transformation methods. Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies - Calculation of changes under selection, Demonstration of genetic drift. Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/ *Goniozus*/Female Bruchids etc.- A test of reproductive effort and fitness. Construction of Life tables and application of Leslie Matrix – population projections, Stable age distribution. Exercises in development of Algorithms for crop modeling.

ENT 605 Insect Behaviour 2(1+1)

Theory

UNIT- I

Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

UNIT- II

Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

UNIT -III

Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Selforganization and insect behaviour.

UNIT- IV

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation

as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

Practical

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees. Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

ENT 606 Recent Trends In Biological Control 2(1+1)

Theory

UNIT -I

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.

UNIT- II

Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

UNIT -III

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation.

UNIT- IV

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

Practical

Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol agents, performance of efficiency analyses on target pests; project document

preparation for establishing a viable mass-production unit /insectary.

ENT 607 Advanced Insecticide Toxicology 3(2+1)

Theory

UNIT -I

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

UNIT -II

Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.

UNIT -III

Joint action of insecticides; activation, synergism and potentiation.

UNIT -IV

Problems associated with pesticide use in agriculture: pesticide resistance, mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

UNIT- V

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

Practical

Sampling, extraction, clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.

ENT 608 Advanced Host Plant Resistance 2(1+1)

Theory

UNIT -I

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors.

UNIT -II

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

UNIT -III

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding.

UNIT -IV

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

Practical

Understanding mechanisms of resistance for orientation, feeding, oviposition *etc.*, allelochemical bases of insect resistance; macroculturing of test insects like aphids, leaf/plant hoppers, mites and stored grain pests; field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

ENT 609 Advanced Acarology 2(1+1)

Theory

UNIT- I

Comparative morphology of Acari, phylogeny of higher categories in

mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

UNIT- II

Management of economical important species of mites in agriculture, veterinary and public health; storage acarology.

UNIT- III

Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites.

UNIT -IV

Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization.

Practical

Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their role in suppression of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens *etc*.

ENT 610 Agricultural Ornithology 2(1+1)

Theory

UNIT -I

Status of agricultural ornithology in India, groups of birds associated with agro-ecosystems. Habitat associations of birds in both wet and dry agricultural systems. Association of birds with different cultivation practices and crop stages, their seasonality and succession. Pestiferous and beneficial birds associated with different crops, their general biology and ecology. Food and feeding habits of birds in crop fields.

UNIT- II

Nature of damage caused by birds in different crops. Foraging ecology of birds in agricultural fields. Birds affecting stored grains in houses and godowns. Beneficial role of birds in agriculture and attracting them to field. Use of bird excreta in agriculture. Management of bird pests in agriculture: physical, cultural, ecological and chemical methods.

Practical

Study of different groups of birds associated with agriculture, their morphology and field identification. Field visits to different agroecosystems. Study of bird associations with different crop stages. Study of nesting and roosting habits of birds in agricultural habitats. Study of the feeding habits, nature and types of damage caused by birds in selected crops. Visits to godowns. Analysis and study of the use of bird excreta in agriculture at a bird sanctuary. Field visits to paddy growing command areas to study birds in crop fields. Assignments on assessing bird damage, estimation of populations etc.

ENT 611 Molecular Approaches in Entomological Research 2(1+1)

Theory

UNIT- I

Introduction to molecular biology; techniques used in molecular biology.

UNIT- II

DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi.

UNIT -III

Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, neuropeptides. Transgenic plants for pest resistance and diseases.

UNIT IV

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.

UNIT- V

DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

Practical

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gel electrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

ENT 612 Advanced Integrated Pest Management 2(2+0)

Theory

UNIT -I

Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.

UNIT -II

Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

UNIT -III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' realtime situations.

UNIT-IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

ENT- 613/ Plant Biosecurity and Biosafety 2(2+0)

PL PATH-606

Theory

UNIT-I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT- II

National Regulatory Mechanism and International Agreements/ Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT- III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

EXTENSION EDUCATION

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)

B.Sc. (Ag.) Courses

Core Courses

EXT-121	Dimensions of Agricultural Extensions	**2(1+1)**
EXT -211	Fundamentals of Rural Sociology and Educational Psychology	**2(2+0)**
EXT -311	Entrepreneurship Development and Communication Skill	**2(1+1)**
EXT -322	Extension Methodologies for transfer of Agricultural Technology	**2(1+1)**

M.Sc. (Ag.) Courses

I. Major (Core Courses)

EXT 501	Development Erspectives of Extension Education	2(1+1)
EXT 502	Development Ommunication and Information Management	3(2+1)
EXT 503	Diffusion and Adoption of Innovations	3(2+1)
EXT 504	Research Methods In Behavioural Sciences	3(2+1)
EXT 505	E- Extension	3(2+1)
EXT 506	Entrepreneurship Development and Management In Extension	3(2+1)
EXT 507	Human Resource Development	3(2+1)
EXT 508	Visual Communication	3(2+1)
EXT 509	Participatory Methods for Technology Development and Transfer	2(1+1)

EXT 510	Gender Sensitization for Development	2(1+1)
EXT 511	Perspectives of Distance Education	2(1+1)
EXT 512	Market Led Extension	2(1+1)

II. Master's Seminar and Research

EXT-591	Master's Seminar	1(1+0)
EXT-599	Master's Research	20(20)

Ph.D. Courses

EXT 601	Advances In Agricultural Extension	3(2+1)
EXT 602	Advanced Designs And Techniques In Social Science Research	3(2+1)
EXT 603	Advances In Training Technology	3(2+1)
EXT 604	Organizational Development	3(2+1)
EXT 605	Advanced Instructional Technology	3(2+1)
EXT 606	Theory Constructions In Social Sciences	2(2+0)
EXT 607	Advanced Management Techniques	3(2+1)
EXT 608	Media Management	3(2+1)
EXT 609	Transfer of Technology In Agriculture	3(2+1)
EXT 691	Doctoral Seminar-I	1(1+0)
EXT-692	Doctoral Seminar-II	1(1+0)
EXT-699	Doctoral Reserach	45(45)

B.Sc. (Ag.) Courses

EXT-121 Dimensions of Agricultural Extension 2 (1+1)

Education–Meaning, Definition, Types – Formal, Informal and Non-formal education and their Characteristics. Extension Education and Agricultural Extension–Meaning, Definition, Concepts,

Objectives and Principles. Rural development – Meaning, Definition, Concepts, Objectives, Importance and Problems in rural development. Developmental programmes of pre-independence era – Sriniketan, Marthandam, Gurgaon experiment and Gandhian constructive proprogramme. Development programmes of Post independence era, Firka Development, Etawah – Pilot project and Nilokheri Experiment. Community Development Programme – Meaning, Definition, Concepts, Philosophy, Principles, Objectives, Differences between Community Development and Extension Education, National Extension service. Panchayat Raj system – Meaning of Democratic – Decentralization and Panchayat Raj, Three tiers of Panchayat Raj system, Powers, Functions and Organizational setup. Agricultural Development Programmes with reference to year of start, objectives & sailent features – Intensive Agricultural District Programme (IADP), High Yielding Varieties Programme (HYVP), Institution Village Linkage Programme (IVLP), Watershed Development Programme (WDP), National Agricultural Technology Project (NATP), ATMA, ATIC. Social Justice and Poverty alleviation programmes – Integrated Tribal Development Agency (ITDA), Integrated Rural Development Programme (IRDP), Swarna Jayanthi Gram Swarojgar Yojana (SGSY), Prime Minsiter Employment Yojana (PMEY). New trends in extension, privatization. Women Development programmes – Development of Women and Children in Rural Areas (DWCRA), Rashtriya Mahila Kosh (RMK), Integrated Child Development Scheme (ICDS) and Mahila Samridhi Yojana (MSY). Reorganized extension system (T&V System) – Salient features, Fort night Meetings, Monthly workshops, Linkages, Merits and Demerits, Emergence of Broad Based Extension (BBE).

PRACTICAL

Visits to a village and to study the ongoing development programmes. Visits to Panchayat Raj Institutions to study the functioning of Gram Panchayat (GP) & Zilla Parishad (ZP). Visit and study of the District Rural Development Agency (DRDA). Participation in monthly workshops of Training and Visit (T & V) System. Visit to Watershed Development Project area. Visit to a village to study the Self Help Groups (SHGs. Visit to a voluntary organization to study the developmental activities. Organizing PRA techniques in a village to identify the agricultural problems.

EXT-211 Fundamentals of Rural Sociology and Educational Psychology 2 (2+0)

Extension Education and Agricultural Extension – Meaning, Definition, Scope and Importance. Sociology and Rural Sociology, Meaning, Definition, Scope, Importance of Rural Sociology in Agricultural Extension and Interrelationship between Rural Sociology & Agricultural Extension. Indian Rural Society, Important characteristics, Differences and Relationship between Rural and Urban societies. Social Groups – Meaning, Definition, Classification, Factors considered in formation and organization of groups, Motivation in group formation and Role of Social groups in Agricultural Extension. Social Stratification – Meaning, Definition, Functions, Basis for stratification, Forms of Social stratification Characteristics and – Differences between Class & Caste System. Cultural concepts – Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions – Meaning, Definition and their Role in Agricultural Extension. Social Values and Attitudes – Meaning, Definition, Types and Role of Social Values and Attitudes in Agricultural Extension. Social Institutions –Meaning, Definition, Major institutions in Rural society, Functions and their Role in Agricultural Extension. Social Organizations – Meaning, Definition, Types of organizations and Role of Social organizations in Agricultural Extension. Social Control – Meaning, Definition, Need of social control and Means of Social control. Social change – Meaning, Definition, Nature of Social change, Dimensions of social change and factors of social change. Leadership – Meaning, Definition, Classification, Roles of a leader, Different methods of Selection of Professional and Lay leaders. Training of Leaders – Meaning, Definition, Methods of training, Advantages and Limitations in use of local leaders in Agricultural Extension. Psychology and Educational Psychology – Meaning, Definition, Scope and Importance of Educational Psychology in Agricultural Extension. Intelligence – Meaning, Definition, Types, Factors affecting intelligence and Importance of intelligence in Agricultural Extension. Personality – Meaning, Definition, Types, Factors influencing the Personality and Role of personality in Agricultural Extension. Teaching – Learning process –Meaning and Definition of Teaching, Learning, Learning experience and Learning situation, Elements of learning situation and its characteristics. Principles of learning and their implication for teaching.

EXT-311 Entrepreneurship Development and Communication Skill 2 (1+1)

Concept of Entrepreneur, Entrepreneurship and Entrepreneurial Behaviour. Dimensions of Entrepreneurial behaviour, factors affecting entrepreneurial behaviour, integrative behavioural framework, differences among Entrepreneurship, managership and leadership, process of entrepreneurship development, developing entrepreneurial motivation. Framework of Entrepreneurship, models and theories of entrepreneurship, training in entrepreneurship. Organizational support for establishment of enterprise.

Communication skill, meaning and process of communication, verbal and non-verbal communication, listening and note taking. Writing skills, oral presentation skills; field diary and lab record, indexing footnote and bibliographic procedures. Reading and comprehension of general and technical articles; summarizing, abstracting; individual and group presentations; public speaking; group discussion. Organizing seminars and conferences.

PRACTICAL

Listening and note taking writing skills, oral presentation skills, field diary and lab record; indexing footnote and bibliographic procedures; reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations.

EXT-322 Extension Methodologies For Transfer of Agricultural Technology 2 (1+1)

Communication – Meaning, Definition, Models, Elements and Barriers in communication. Extension Teaching methods – Meaning, Definition, Functions and Classification. Individual contact methods – Farm and Home visit, Result Demonstration, Field trials – Meaning, Objectives, Steps, Merits and Demerits. Group contact methods – Group discussion, Method demonstration, Field Trips – Meaning, Objectives, Steps, Merits and Demerits. Small group discussion techniques – Lecture, Symposium, Panel, Debate, Forum, Buzz group, Workshop, Brain Storming, Seminar and Conference. Mass contact Methods – Campaign, Exhibition, Kisan Mela, Radio & Television – Meaning, Importance, Steps, Merits & Demerits. Factors influencing in selection of Extension Teaching Methods and Combination (Media Mix) of

Teaching methods. Innovative Information sources – Internet, Cyber Cafes, Kisan call centers. Diffusion and Adoption of Innovations – Meaning, Definition, Models of adoption Process, Innovation Decision Process, Adopter categories and their characteristics, Factors influencing adoption process. Capacity building of Extension Personnel and Farmers –Meaning, Definition, Types of training, Training to farmers, farm women and Rural youth –FTC and KVK.

PRACTICAL

Simulated exercises on communication. Identifying the Problems, Fixing the Priorities and selecting a most important problem for preparation of a project. Developing a project based on identified problems in a selected village. Organization of Group discussion and Method demonstration. Audio Visual aids – Meaning, Importance and Classification. Selection, Planning, Preparation, Evaluation and Presentation of visual aids. Planning & Preparation of visual aids – Charts, Posters, Over Head Projector, (OHP) Transparencies, Power Point Slides. Handling of OHP and Liquid Crystal Display (LCD) Projector.

M.Sc. (Ag.) Courses

EXT 501 Development Perspectives of Extension Education 2(1+1)

Theory

UNIT I

Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.

UNIT II

Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University.

UNIT III

Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

UNIT IV

Current Approaches in Extension: Decentralised Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centres, NAIP.

Practical

Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

EXT 502 Development Communication and Information Management 3(2+1)

Objective

In this course, students will learn about the concept, meaning and process of communication and various methods and modern media of communication.Besides, the students will also learn the information management and journalistic writing of various information materials and also study their readability.

Theory

UNIT I

Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

UNIT II

Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development.

UNIT III

Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media – Electronic video, Tele Text, Tele confer ence, Computer Assisted Instruction, Computer technology and its implications.

UNIT IV

Agricultural Journalism as a means of mass communication, Its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

EXT 503 Diffusion and Adoption of Innovations 3(2+1)

Theory

UNIT I

Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice.

UNIT II

The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation.

UNIT III

Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.

UNIT IV

Diffusion effect and concept of over adoption, opinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.

Practical

Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

EXT 504 Research Methods in Behavioural Science 3(2 + 1)

Theory

UNIT I

Research – Meaning, importance, characteristics. Behavioural sciences research – Meaning, concept and problems in behavioural sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature, Planning the review work. Research problem – Selection and

Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem.

UNIT II

Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximincon Principle, Sampling – Types of sampling and sampling procedures.

UNIT III

Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre –

testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in conducting, advantages and limitations in its use. Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations.

UNIT IV

Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.

Practical

Selection and formulation of research problem - Formulation of objectives and hypothesis-Selection of variables based on objectives-Developing the conceptual framework of research. Operationally defining the selected variables-Development of data collection devices.-Testing the validity and reliability of the data collection instruments.- Pre-testing of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, hands on experiences on SPSS, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research.Writing report, Writing of thesis and research articles-Presentation of reports.

EXT 505 E- Extension 3(2+1)

Theory

UNIT I

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities.

UNIT II

ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in the field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III

Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. Knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts.

UNIT IV

ICT: Extension approaches-pre-requisites, information and science needs of farming community. Need integration. Human resource information. Intermediaries. Basic e-extension training issues. ICT enabled extension pluralism. Emerging issues in ICT.

Practical

Agril.content analysis of ICT Projects. Handling of ICT tools. Designing extension content. Online extension service. Project work on ICT enabled extension. Creation of extension blogs. Visit to ICT extension projects.

EXT 506 Entrepreneurship Development and Management in Extension 3(2+1)

Theory

UNIT I

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects.

UNIT II

Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries. Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social Marketing.

UNIT III

Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Effective making planning. Change Management – factors,

process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

UNIT IV

Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization. Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles. Organizational Communication – Concept, Process, Types, Networks, Barriers to Communication. Managing work motivation – Concept,

Motivation and Performance, Approaches to motivation. Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision. Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

Practical

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs, Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions-Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

EXT 507 Human Resource Development (HRD) 3(2+1)

Objective

To orient the students about key concepts, importance, scope & conceptual frame work, growth & development of Human Resource Development, Subsystems of Human Resource Development for extension organization and process of HRD.

Theory

UNIT I

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual framework, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction, Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity - job description – analysis and evaluation; Performance Appraisal.

UNIT II

Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception ; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning,

Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Skills required for Extension workers; Decision Making:

Decision Making models, Management by Objectives; Behavioural Dynamics :Leadership styles – Group dynamics.

UNIT III

Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation; Facilities for training – Trainers training – techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospectives.

Practical

Visit to different training organizations to review on going activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers, Studies on evaluation of training programmes; Study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and Human resource information, Presentation of reports.

EXT 508 Visual Communication 3(2+1)

Theory

UNIT I

Role of visuals & graphics in Communication. Characteristics of visuals & graphics. Functions of visuals and graphics. Theories of visual perception. Classification and selection of visuals.

UNIT II

Designing message for visuals, Graphic formats and devices. Presentation of Scientific data. Principles and procuction of low cost visuals.

UNIT III

Photographs- reprographic visuals. PC based visuals. Degitized video material in multimedia production. Designing visuals for print and TV and video.

UNIT IV

Pre-testing and evaluation of visuals. Scanning of visuals.

Practicals

Preparation of low cost projected and Non-Projected visuals. Designing and layout of charts, posters, flash cards etc. Power point presentations. Generating computer aided presentation graphics. Scanning and evaluation of visuals.

EXT 509 Participatory Methods for Technology Development and Transfer 2(1+1)

Theory

UNIT I

Participatory extension – Importance, key features, principles and process of participatory approaches; Different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, ESRE, FPR) and successful models.

UNIT II

Participatory tools and techniques. Space Related Methods : village map (social & resource), mobility services and opportunities map and transect; Time related methods : time line, trend analysis, seasonal diagram. Daily activity schedule, dream map; Relation oriented methods : cause and effect diagram (problem tree), impact – diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis.

UNIT III

Preparation of action plans, concept and action plan preparation; Participatory technology development and dissemination; Participatory planning and management, phases and steps in planning and implementation aspects; Process monitoring, participatory evaluation.

Practical

Simulated exercises on space related methods, time related method and relation oriented methods; Documentation of PTD and dissemination; Preparation of action plan; Participatory monitoring and evaluation of developmental programmes.

EXT 510 Gender Sensitization for Development 3(2+1)

Objective

In this course the students will learn about an overview of the concept of gender and gender balance on development and develop skills of identifying gender roles, rights, responsibilities and relationships on development. Besides the students will also learn the attitudinal change to internalize gender equity concerns as fundamental human rights and also enhance the capability for identifying and analyzing gender issues in agriculture and allied sectors.

Theory

UNIT I

Gender concepts, issues and challenges in development; Gender roles, gender balance, status, need and scope; Gender analysis tools and techniques.

UNIT II

National policy for empowerment of women since independence; Developmental programmes for women; Gender mainstreaming in agriculture and allied sectors –need and relevance; Gender budgeting – A tool for empowering women.

UNIT III

Women empowerment –Dimensions; Women empowerment through SHGapproach; Women entrepreneurship and its role in economic development; Public Private Partnership for the economic empowerment of women; Building rural institution for women empowerment; Women human rights ; Action plans for gender mainstreaming.

Practical

Visits to rural institutions of women for studying in the rural institutions engaged in Women empowerment; Visits to entrepreneurial unit of women for studying the ways and means of establishing entrepreneurship units

for Women and their development and also SWOT analysis of the Unit; Visit to Center for women development - NIRD to study the different activities related to projects and research on gender; Visit to gender cell, Office of the Commissioner and Director of Agriculture, Hyderabad, to study the mainstreaming of gender concerns and gender budget of the department.

EXT 511 Perspectives of Distance Education 2(2+0)

Objective

The course is intended to orient the students with the concept of Distance Education, Characteristics of Distance Education, Evolution, Methods of Distance Education, Different Approaches in Planning Distance Education, Educational Technology in Distance Education, Management of Resources for distance education, Strategies for maximizing the reach and programme evaluation and quality assessment.

Theory

UNIT I

Distance Education – Introduction Meaning, Concept, Philosophy and its work ethics, characteristics of Distance Education – Evolution and Historical view of Distance Education – Theory Methodology, and Epistemology. Dimensions of Distance Education, Scope and difficulties. Open Education – Non-formal Education, Continuing Education, Education by correspondence.

UNIT II

Forms and systems of Distance and Open Education, Modes of Teaching and Learning in Distance Education, Methods of Distance Education, Significance of Distance Education in Teacher Education.

UNIT III

Planning Distance Education – A Systems Approach Student Learning – Course Planning, The target groups – Barriers to learning in Distance Education – Planning and Management of Networked Learning.

UNIT IV

Educational Technology is Distance Education Application of information and Educational Technologies in Distance Education, Development of Course and Course material, Management of resources, processes, Forms of Instructional material in Distance Education and Media Development and Production in Distance Education - Video Classroom Strategy in Distance Education –Strategies for maximizing the reach – services to students, programme Evaluation - performance indicators and Quality Assessment.

Practical

Visit to the University which is implementing the Distance Education Programmes. Detailed Study of their programme in relation to Educational Technology, Methodology, Curriculum Development, Evaluation and Assessment. Exercise on development of curriculum for Distance Education exclusively for farming community.

EXT 512 Market Led Extension 2(2+0)

Theory

UNIT I

Agricultural extension at cross roads; Changing scenario of agricultural extension at the national level; Market led extension – emerging perspectives; Market led extension – issues and challenges; Dimensions of market led extension.

UNIT II

Agricultural marketing an overview; Development of a marketing plan, pricing concepts and pricing strategy; Consumer behaviour; Marketing communication and promotional strategies; The marketing research process; Agricultural trade liberalization and its impact; International marketing opportunities; Implications of AOA, TRIPS and IPRs agreements on agriculture; Agreement on SPS and TBT - an over view; Commodity features marketing.

UNIT III

Public private linkages in market led extension; Role of SHG in market led extension; Contact farming – a viable approach to meet market challenges; IT enabled approaches for market led extension and communication; Weather service and crop modeling – An effective tool in market led extension.

Practical

Identification and analysis of different marketing sources for agricultural commodities. Development of strategy for an effective market intelligence system; Development of suitable marketing plan to suite rural situation; Visit to APEDA, Rythu Bazaars to study the processes and procedures related to market-led extension.

Ph.D. Courses

EXT 601 Advances in Agricultural Extension 3(2+1)

Theory

UNIT I

Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

UNIT II

Cyber Extension - Concept of cyber extension, national and international cases of extension projects using ICT and their impact on agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research - Extension -Farmer - Market linkage: Importance, Scope, Implications etc., Market - Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm

School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership. Stakeholder's analysis in Extension. Main streaming gender in Extension - Issues and Prospects.

UNIT III

Implications of WTO - AOA for extension services, re-orientation of extension services for agri-business and marketing activities, GOI-NGO collaboration to improve efficiency of extension.

UNIT IV

Extension and contemporary issues: Extension and issues related to rural poverty. Privatization of Extension. Intellectual Property Rights (IPRs). Extension Reforms in India - Decentralized decision making, Bottom up planning, Farming System and Situation based Extension Delivery System, Extension delivery through Commodity Interest Groups. Organization innovations in Extension - ATIC, IVLP, Kisan Call Centres.

Practical

Analysis of ITK systems, cases on integration of ITK and formal research system, Analysis of cases on cyber extension and privatization of extension. Analysis of ATMA and SREP. Practicing bottom up planning. Visit to Public-Private -Farmer partnership. Learnings from Food and Nutritional Security and bio-diversity Projects and Programmes.

EXT 602 Advanced Designs and Techniques in Social Science Research 3(2+1)

Theory

UNIT I

Scaling technique - meaning, types, principles, steps and quality, techniques of attitude scale construction - Paired comparison, Equal appearing intervals, Successive Intervals, Summated ratings, Scalogram analysis, Scale discrimination technique, Reliability and Validity of Scales. Sociometrics, content analysis, case studies, Q-sort techniques, Semantic differential technique.

UNIT II

Projective and Semi projective techniques, Critical incident techniques, Computer packages for analysis - usage in Extension Research. Knowledge scale measurement. Participatory tools and techniques in behaviour Research - Data collection and Evaluation. Impact analysis, e-data collection and information analysis.

Practical

Practice in constructing a scale and use of scale in various situations. Reliability and validity of the scales developed, Application of Semi Projective and Projective techniques. Content analysis, case studies. Practicing participatory tools and techniques. Hands on experience on Computer Preparation and Data Collection instruments, review of previous studies.

EXT 603 Advances in Training Technology 3(2+1)

Theory

UNIT I

Paradigm shift in training - learning scenario, Training Approaches - Experiential learning - laboratory - organization development (system) approaches; Training Design, Designing an effective training programme, Harmonizing training needs, Course Objective, content and methods.

UNIT II

Designing an effective training session - the semantics involved, Designing experiential training sessions, simulation exercises, and openness in training transaction - managing dilemmas, ambivalence and conflicts and confusion (for both trainers and trainees).

UNIT III

Recent Training Techniques for understanding and facilitation team building, group dynamics, motivation and empowerment, laboratory methods: micro-lab process work, and sensitivity training, Psychological instruments as training tools: TAT, Inventories, Cases, etc.

UNIT IV

Participatory Training Techniques - Lecture, Brainstorming, Group discussion and Training Games. Role Play, Psycho-drama, Coaching, Counseling, etc., Trainer's roles and dilemmas, Factors Effecting Training Effectiveness and Training Evaluation.

Practical

Techniques of participatory training need assessment. Formulation of Course Objective, design of training programmes. Simulation exercises. Participatory training methods - Role Play & Brainstorming, Group discussion and Counseling and Conducting experiential learning sessions. Training evaluation - Techniques of Knowledge, Skill & Attitude evaluation. Visit to training institutions and study of training technologies followed.

EXT 604 Organizational Development 3(2+1)

Theory

UNIT I

Introduction to organizations: Concept and Characteristics of organizations, Organizational Behvaiour - Context and concept - levels of organizations - formal and informal organizations, Theories of organizations: Nature of organizational theory - classical theories - features of Bureaucracy - administrative theory and Scientific management - Neo-classical theories - the human relations movement - modern theory.

UNIT II

Systems approach to study organization needs and motives - Attitude, values and ethical behaviour - alienation and work - work motivation - communication and interpersonal behaviour - organization communication - leadership behaviour - decision making, problem solving techniques - organizational climate - change

proneness and resistance to change, Organizational change, Organizational structure - Process in organizing - Dimension of Motivation Climate.

UNIT III

Departmentation - Span of Management - Delegation of authority - Centralization and decentralization - line and staff organization - functional organization - divisonalisation - Project organization - Matrix organization - free form organization - top management structure.

UNIT IV

Individual behaviour in organization. Fundamentals of Human relations and Organizational behaviour, Groups and teams - Organisational culture and performance. Dynamics of Organization behaviour - leadership conflict situations and inter group behavior- Organisational Development - Factors effecting organization effectiveness. Creativity, leadership, motivation and organization development.

Practical

Analysis of organization in terms of process - attitudes and values, motivation, leadership. Simulation exercises on problem-solving - Study of organizational climate in different organizations. Study of organizational structure of development departments, Study of departmentalization, span of control, delegation of authority, decisions making patterns, Study of individual and group behaviour at work in an organization. Conflicts and their management in an organization. Comparative study of functional and non-functional organsiations and drawing factors for organizational effectiveness.

EXT 605 Advanced Instructional Technology 3(2+1)

Objective

By the end of the course student will be able to Understand Agricultural Education Scenario in the country and Curriculum development process, Plan & Prepare and present course outline, Lesson Plan & Skill plan, Develop appropriate Teaching & Learning Styles, Use innovative instructional aids & methods

Theory

UNIT I

Concepts in Instructional Technology, Scope of Instructional Technology. History of agricultural education in India. Guidelines for curriculum development in Agricultural Universities. Curriculum design development.

UNIT II

Course outline, Lesson plans for theory and practicals. Teaching and learning styles. Theories of learning. Cognitive levels. Instructional Course Objective. Motivation of students.

UNIT III

Instructional Methods. Experiential learning cycle. Innovative Instructional Aids. Computer Assisted Instruction. Programmed instruction technique. Team Teaching. E-Learning, Art of Effective Communication. Distance education. Student evaluation - Question Bank. Appraisal of Teacher Performance. Review of research in Instructional Technology.

Practical

Formulation of instructional Course Objective. Development and presentation of course outlines. Preparation & presentation of lesson plans for theory & practical with CAI design. Preparation of innovative low cost instructional aids. Development of model question bank. Preparation of schedule for teacher evaluation. Visit to Distance Education centre. Study of research reviews and Presentation of reports.

EXT 606 Theory Constructions In Social Sciences 2(2+0)

Theory

UNIT I

Importance of theory constructions in social science. Theory: Meaning, elements, Ideal Criteria, Functions, Types. Definitions: Meaning, types and Rules.Generalizations: Meaning, Classification. Relationship: Meaning Types.

UNIT II

Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived. Steps in theory building - Axiomatic Techniques, Historical approaches. Scientific application Theoretical concept in Social Sciences. Test of Theory: Applying appropriate statistical tests.

EXT 607 Advanced Management Techniques 3(2+1)

Theory

UNIT I

Management Information System (MIS): Basic concepts, types of information needed at various levels, design of MIS in an agricultural extension organization. Scope for computerization, system alternatives and Evaluation. Implementation, operation and maintenance of the MIS system.

UNIT II

Management by Course Objective (MBO): Elements of the MBO system. The Process of MBO. Making MBO effective. Evaluation of the MBO system - strengths and weaknesses. Transactional Analysis (TA): Ego states, transactions, inter relationships, strokes, stamps.

UNIT III

Managing Organizational Stress: Sources of stress in organization, effect of stress. Coping mechanisms and managing stress, Stress management, Team Building Process: Types of teams. Steps in teamwork, Facilitators and barriers to effective relationships, nature of prejudice, tips in reducing interpersonal conflicts, inter-group conflict, resolving techniques. Conflict management, tips in reducing interpersonal conflicts.

UNIT IV

Decision Support Systems (DSSs): Basic information about Artificial Intelligence (AI) Expert System (ESs), their future applications in extension system. Forecasting techniques - time series analysis and Delphi, decision making and talent management PERT, CPM Techniques and time management.

Practical

Managements Information system, in research & development organizations. Study of Management by Objective in an organization. Transactional Analysis, exercises on Team building process, coping skills with organizational stress, exercises on Decision Support Systems (DSSs). Practical exercise on forecasting techniques, Visit to Management organizations.

EXT 608 Media Management 3(2+1)

Theory

UNIT I

Media Management – Introduction, Definition, Principles and Significance of Management. Media Ownership patterns in India – Proprietorship, Partnership, private Ltd, Public companies, Trusts, Co-operatives, Religious Institutions (Societies) & Franchisees (Chains). Marketing Function – Product, Price, and Placement & Promotions.

UNIT II

Mass Communication – Meaning, Concept, Definition and Theories of Mass Communication. The Mass Media – History, functions, uses and Theories of Media. Journalism – Meaning, definition, Scope, functions and different types of Journalism. Journalism as communication tool. Farm Journalism – meaning and Developments in Farm Journalism in India. Different problems with Farm Journalism. Print Media – History, the role of the press, news, Types of News, electronics of News and Sources of News, the making of newspaper & magazines, press codes and ethics, Media Laws. News story – Principles of writing, structure a news story, procedure in writing the news story and the elements of style. Success stories & feature articles – writing for success & feature articles, Types of Feature articles. Information materials – Types of information materials and user. Techniques in book Publishing. Editing – Pr inciples, Tools & Techniques and art of Proof Reading – Techniques, Measuring Readability of writing.

UNIT III

Electronic Media-Role and Importance of Radio -History, Radio Role in TOT, writing and presentation techniques, Different Programmes of Farm Broadcast, developing content for farm broadcast, Role of FM Radio in Agriculture, Ethics of Broad casting, Broadcasting Policy and code. Community Radio – Concept, meaning, role in TOT, Cases of Community radio. Television – History - Role in TOT , Fundamentals of Television Production, Techniques of Script writing for TV, Visual Thinking, language & Style, Farm Telecast programmes, cable and satellite TV and their impact, Ethics of Telecasting, policy and code. Video Production Technology – Potential and its utilization, Typology of farm Video production, Types of Video Production and equipment used in the production, Procedure or Technique of video production. Cassette Technology – Role in TOT, Techniques of production of cassettes for the farming community. Traditional Media – Role of Folk Media in TOT and integration with electronic media.

UNIT IV

Advances in communication Technology – Management of Agricultural Information System (MAIS). Use of computers in Agriculture – Application of IT in Agriculture. Use of Modern Communication Medium-Electronic Video, Teletext, tele conference, Computer assisted instruction, Video conferencing, - Features, Advantages, Limitations and risk factory involved in New Media. Designing and developing of communication and media strategy for developmental programmes. Online journalism, scope & importance.

Practical

Exercise on Writing for Print Media – Writing News / Success Stories / Feature articles for different topics related to Agriculture & allied fields. Exercise of editing & proof reading the Farm News for News papers – different types of intro and leads. Exercise of Writing for Radio, TV, Preparation of story board for farm Video Production – Script writing for Radio and T.V. Visit to media management organizations for studying the principles, procedures and processes in managing the media. Participation and Interaction through video conference. Developing communication & Media Strategy for selected developmental programme / activity.

EXT 609 Transfer of Technology in Agriculture 3(2+1)

Theory

UNIT I

Technology - Meaning and Concepts - Appropriate technology, transfer of technology - meaning and concepts. Systems of transfer of technology - Knowledge Generating System (KGS) - Knowledge Disseminating System (KDS) - Knowledge Consuming System (KCS) - Input Supplying Agencies System (ISAS).

UNIT II

Appropriateness of communication media in the system of technology transfer. New communication strategy for transfer and adoption of Agricultural technology. Extension training in transfer of technology.

UNIT III

Analysis. Constraints in Transfer of Technology, agencies or departments involved in TOT. Extension professional in TOT. Attributes of Technology and its Relation in TOT process. TOT to resource poor farmers. Role of Key communicators or local leaders in TOT. Private and Public partnership in TOT.

Practical

Analysis of Transferred technology. Analysis of knowledge generation and consuming systems. Formulation of communication strategies, Study of attributes of selected fast spreading technologies and slow technologies, study of constraints in TOT, visit to TOT centres of ICAR and SAU, Identification of key communicators, Case studies of Public-Private Partnerships, Visits to the print and electronic media centres to study their role in TOT.

FARM ENGINEERING

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)
B.Sc. (Ag.) Courses		
Core Courses		
ENGG-111	Fundamentals of Soil and Water Conservation Engineering	3 (2+1)
STAT-121	Statistics	2 (1+1)
COMP-121	Introduction to Computer Applications	2 (1+1)
ENGG-211	Farm Power and Machinery	2 (1+1)
ENGG-221	Protected Cultivation and Post Harvest Technology	2 (1+1)
ENGG-321	Renewable Energy	2 (1+1)
M.Sc. (Ag.) Courses		
STAT 501	STATISTICAL METHODS FOR APPLIED SCIENCES	3(2+1)
STAT 502	EXPERIMENTAL DESIGNS	3(2+1)
STAT 511	MATHEMATICAL METHODS FOR APPLIED SCIENCES	2(2+0)
STAT 512	NON PARAMETRIC AND MULTIVARIATE ANALYSIS	3(2+1)
STAT 601	SAMPLING TECHNIQUES	3(2+1)

NOTE:
1. STAT-501 course is compulsory for all M.Sc. students.
2. There is no M.Sc. (Agricultural Statistics) programme in the department.

1. Ph.D. Courses in Agricultural Statistics

STAT-601	SAMPLING TECHNIQUES	3(2+1)
STAT 602	ADVANCED STATISTICAL COMPUTING	3(2+1)
STAT 603	SIMULATION TECHNIQUES	3(2+1)
STAT 611	ADVANCED STATISTICAL METHODS	3(2+1)
STAT 612	ADVANCED STATISTICAL INFERENCE	3(2+1)
STAT 613	ADVANCED DESIGN OF EXPERIMENTS	3(2+1)
STAT 614	ADVANCED SAMPLING TECHNIQUES	3(2+1)
STAT 616	STATISTICAL MODELING	3(2+1)
STAT 617	ADVANCED TIME SERIES ANALYSIS	3(2+1)
STAT 618	STOCHASTIC PROCESSES	3(2+1)
STAT 619	SURVIVAL ANALYSIS	3(2+1)
STAT 651	RECENT ADVANCES IN THE FIELD OF SPECIALIZATION	2(2+0)
STAT 691	DOCTORAL SEMINAR I	1(1+0)
STAT 692	DOCTORAL SEMINAR II	1(1+0)
STAT 699	DOCTORAL RESEARCH	45(45+0)

NOTE:

1. STAT 601 and STAT 602 are supporting courses. These are compulsory for all the students of Agricultural Statistics.
2. STAT 691, STAT 692, STAT 651 and STAT 699 are compulsory for all the students of Agricultural Statistics.
3. A student has to take a minimum of 18 credits course work, excluding the supporting courses, seminar and research. A student has to take two seminars.

2. Ph.D. Courses in Agricultural Enigneering (Soil & Water Conservation Engineering)

SWE 601*	ADVANCED HYDROLOGY	3+0
SWE 602*	SOIL AND WATER SYSTEMS' SIMULATION AND MODELLING	2+1

SWE 603	MODELLING SOIL EROSION PROCESSES	2+1
SWE 604	ADVANCED HYDRO-MECHANICS IN SOIL AQUIFER SYSTEMS	3+0
SWE 605	HYDRO-CHEMICAL MODELLING AND POLLUTANT MANAGEMENT	3+0
SWE 606	PLANT GROWTH MODELLING AND SIMULATION	3+0
SWE 607	ADVANCES IN IRRIGATION AND DRAINAGE	2+0
SWE 608	REMOTE SENSING TECHNIQUES FOR NATURAL RESOURCES	2+1
SWE 609	WATER RESOURCES PLANNING AND MANAGEMENT	2+ 1
SWE 691	DOCTORAL SEMINAR I	1+0
SWE 692	DOCTORAL SEMINAR II	1+0
SWE 693	SPECIAL PROBLEM	0+1
SWE 694	CASE STUDY	0+1
SWE 699	DOCTORAL RESEARCH	45

* Compulsory for Doctoral programme

3. Ph.D. Courses in Agricultural Enigneering (Bio Process and Food Engineering)

BPFE-601	: ADVANCE AGRICULTURAL PROCESSING FOR VALUE ADDITION	3 (2+1)
BPFE-602	: RHEOLOGY, CHEMISTRY, & PHYSICS OF BIOLOGICAL MATERIALS	3 (2+1)
BPFE-603	: ADVANCE FOOD ENGINEERING AND TECHNOLOGY	3 (2+1)
BPFE-604	: ADVANCES IN GRAIN DRYING	3 (2+1)
BPFE-605	: STORAGE TECHNOLOGY FOR AGRICULTURAL PRODUCE	3 (2+1)
BPFE-606	: PRODUCT PROCESSING OF HORTICULTURAL AND PLANTATION CROPS	3 (2+1)
BPFE-607	: EQUIPMENT AND PROCESS FOR CONFECTIONARY AND CONVENIENCE FOOD	3 (2+1)

BPFE-650	: COURSE SEMINAR	1 (0+1)
BPFE-651	: SYNOPSIS SEMINAR	1 (0+1)
BPFE-652	: THESIS PRE-SUBMISSION SEMINAR	1 (0+1)
BPFE-660	: THESIS	50

B.Sc. (Ag.) Courses

ENGG-111: Fundamentals of Soil and Water Conservation Engineering **3 (2+1)**

Surveying: chain survey, cross staff survey, plotting procedure, calculations of area of regular and irregular fields. Levelling – levelling equipment, terminology, methods of calculation of reduced levels. Irrigation Water source. Centrifugal pump – capacity, power calculations. Irrigation water measurement – weirs, flumes and orifices. Water conveyance systems – open channel and underground pipeline. Irrigation methods. Irrigation efficiency. Soil and water conservation – erosion, factor affecting erosion, erosion control methods. Land capability classification. Runoff – factor affecting runoff, calculation of peak runoff rate.

Practical: Acquaintance with chain survey equipment; Ranging and measurement of offsets; Chain triangulation; Cross staff survey; Plotting of chain triangulation, Plotting of cross staff survey; Levelling equipment – dumpy level, levelling staff, temporary adjustments and staff reading; Differential leveling; Profile leveling; Study of centrifugal pumping system and irrigation water measuring devices; Study of different components of drip and sprinkler irrigation systems; Uniformity of water application in drip and sprinkler systems; Study of soil and water conservation measures.

STAT-121: Statistics **2 (1+1)**

Introduction: Definition of Statistics and its use and limitations; Frequency Distribution, diagrams and Frequency Curves; Measures of Central Tendency: Characteristics of Ideal Average, Arithmetic Mean; Geometric Mean, Hormonic Mean; Median, Mode, Merits and Demerits of Measures of central tendency; Measures of Dispersion: Standard Deviation, Variance and Coefficient of Variation; Probability: Definition and concept of probability; Test of Significance - Types of Errors, Null Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis; Large ONE Sample Test - SND test for Mean, Single Sample; Small Sample Test for Mean, Student's t-test for single Sample, Correlation: Types of

Correlation and identification through Scatter Diagram, Computation of Correlation Coefficient 'r'. Linear Regression: of Y on X and X on Y.The regression coefficients, fitting of regression equations.

Practical: Construction of Frequency Distribution Tables and Frequency Curves; Computation of Arithmetic Mean, Geometric Mean, Hormonic Mean for Un-Grouped and Grouped data; Computation of Median for Un-Grouped and Grouped data; Computation of Mode for Un-Grouped and Grouped data; Computation of Standard Deviation, Variance and Coefficient of Variation for Un-Grouped and Grouped data; SND test for Mean, Single Sample, Student's t-test for Single Sample; Computation for Correlation Coefficient 'r'; Fitting of regression equations-Y on X and X on Y.

COMP-121: Introduction to Computer Applications **2 (1+1)**

History and Introduction to Computers, Anatomy of Computers, Input and Output Devices. Units of Memory, Hardware, Software and Classification of Computers. Personal computers, Types of Processors, booting of computer, Warm and cold booting. Computer Viruses, Worms and Vaccines. Operating System-DOS and WINDOWS. Disk Operating System (DOS): Some fundamental DOS Commands, FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD and DELTREE, Rules for naming files in DOS and Types of files. WINDOWS : GUI, Desktop and its elements, WINDOWS Explorer, working with files and folders; setting time and date, starting and shutting down of WINDOWS. Anatomy of a WINDOW, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars. Applications-MSWORD: Word, processing and units of document, features of word-processing packages. Creating, Editing, Formatting and Saving a document in MSWORD; MSEXCEL: Electronic Spreadsheets, concepts, packages. Creating, Editing and Saving a spreadsheet with MSEXCEL. Use of in-built Statistical and other functions and writing expressions. Use of Data Analysis Tools, Correlation and Regression, t-test for two-samples and ANOVA with One-way classification. Creating Graphs. MS Power Point: Features of Power Point Package. MSACCESS: Concept of Database, Units of database, creating database; Principles of Programming: Flow Charts and Algorithms, illustration through examples. Internet: World Wide Web (WWW), Concepts, Web Browsing and Electronic Mail

Practical: Study of Computer Components; Booting of Computer and its Shut Down; Practice of some fundamental DOS commands, TIME, DATE, DIR, COPY, FORMAT, VOL, LABEL, PATH; Practicing WINDOWS Operating System, Use of Mouse, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars; WINDOWS Explorer, Creating Folders, COPY and PASTE functions; MSWORD: Creating a Document, Saving and Editing; MSWORD, Use of options from Tool Bars, Format, Insert and Tools (Spelling and Grammar) Alignment of text; MSWORD, Creating a Table, Merging

of Cells, Column and Row width; MSEXCEL: Creating a Spreadsheet, Alignment of rows, columns and cells using Format tool bar; MSEXCEL: Entering Expressions through the formula tool bar and use of inbuilt functions, SUM, AVERAGE, STDEV; MSEXCEL: Data Analysis using inbuilt Tool Packs, Correlation and Regression; MSEXCEL: Creating Graphs and Saving with and without data; MSACCESS: Creating Database, Structuring with different types of fields; MS Power Point: Preparation of slides on Power Point; Transforming the data of WORD, EXCEL and ACCESS to other formats; Internet Browsing: Browsing a Web Page and Creating of E-mail ID.

ENGG-211: Farm Power and Machinery **2 (1+1)**

Farm power– Farm power in India: sources, I.C. engines, working principles of two stroke and four stroke engines, I.C. engine terminology, Cooling and Lubrication of I. C. engine. Cost of tractor power.

Farm Machinery –Tillage implements: Primary and Secondary tillage implements, Implements for intercultural operations, seed drills, field efficiency, paddy transplanters, Introduction of harvesting and threshing equipments.

Practical: Study of different component of I.C. Engine; Study of working of four stroke engine; Study of working of two stroke engine; Study of M.B. plough, measurement of plough size, different parts, horizontal and vertical suction, determination of line of pull etc.; Study of disc plough; Study of seed-cum-fertilizer drills-furrow openers, metering mechanism and calibration; Study, maintenance and operation of tractor; Learning of tractor driving; Study, maintenance and operation of power tiller; Study of different parts, registration, alignment and operation of mower. Study of different inter cultivation equipment in term of efficiency, field capacity.

ENGG-221: Protected Cultivation and Post Harvest Technology **2 (1+1)**

Green house technology; Introduction, Types of Green Houses, Green house equipment, materials of construction for traditional and low cost green houses. Groundnut decorticators; hand operated and power operated decorticators, principles of working, care and maintenance. Drying; grain drying, types of drying, types of dryers. Storage; grain storage, types of storage structures. Fruits and vegetable grading; methods of grading, equipment for grading of fruits and vegetables. Size reduction; equipment for size reduction, care and maintenance. Processing of cereals, pulses and oil seeds.

Practical: Study of different types of green houses based on shape, construction and cladding materials. Visit to commercial green houses, Study of different components of groundnut decorticator. Study of improved grain storage structure, Study of

dryers, Study of cleaners and graders. Study of wheat and rice milling equipments. Study of pulse milling equipments. Study of oil expeller and filtration unit.

ENGG-321: Renewable Energy **2 (1+1)**

Energy sources– Introduction, Classification; Energy from Biomass– Types of biogas plants, Biogas production and its utilization, Agricultural wastes; Principles of combustion, pyrolysis and gasification, Solar energy and its applications. Solar photo voltaic systems, Solar pumping system, Wind energy, Types of wind mills, application of wind mills, Liquid Bio fuels, Bio diesel and Ethanol from agricultural produce, its production and uses.

Practical: Constructional details of KVIC and Deen Bandu type biogas plants; Field visit to biogas plants; To study and find the efficiency of solar cooker; Study and working of solar photovoltaic pumping system; Study and performance evaluation of domestic solar water heater; Study and performance evaluation of solar lantern; To study and performance evaluation of solar inverter; To study the performance of different types of wind mills; Field visit to wind mills; To study the processing of Bio-diesel production from Jatropha.

M.Sc. (Ag.) Courses

STAT 501 Statistical Methods for Applied Sciences **3(2+1)**

Theory

UNIT I

Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

UNIT II

Discrete and continuous probability distributions: Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions. Large sample theory.

UNIT III

Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Testing for heterogeneity.

Practical

On the topics listed in the theory syllabus.

STAT 502 Experimental Designs 3(2+1)

Theory

UNIT I

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

UNIT II

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT III

Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

Practical

On the topics listed in the theory syllabus.

STAT 511 Mathematical Methods for Applied Sciences 2(2+0)

Theory

UNIT I

Variables and functions; limit and continuity. Specific functions. Differentiation: theorems of differentiation, differentiation of logarithmic, trigonometric, exponential and inverse functions, function of a function, derivative of higher order, partial derivatives. Application of derivatives in agricultural research; maxima and minima in optimization.

UNIT II

Integration as a reverse process of differentiation, methods of integration, reduction formulae, definite integral; Applications of integration in agricultural research with special reference to economics and genetics, engineering.

UNIT III

Matrices, notations and operations, laws of matrix algebra; transpose and inverse of matrix; Eigen values and eigen vectors. Determinants - valuation and properties of determinants, application of determinants and matrices in solution of equation for economic analysis.

STAT 512 Non Parametric Tests and Multivariate Analysis 3(2+1)

Theory

UNIT I

Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

UNIT II

Introduction to multivariate analytical tools- Hotelling's T^2 Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D^2-statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

Practical

On the topics listed in the theory syllabus.

Ph.D. Courses

1. Agricultural Statistics

STAT 601 SAMPLING TECHNIQUES 3(2+1)

Theory

UNIT I

Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population.

UNIT II

Simple random sampling, sampling for proportion, determination of sample size; inverse sampling, Stratified sampling.

UNIT III

Cluster sampling, PPS sampling, Multi-stage sampling, double sampling, systematic sampling; Use of auxiliary information at estimation as well as selection stages.

UNIT IV

Ratio and regression estimators. Construction and analysis of survey designs, sampling and non-sampling errors; Preparation of questionnaire Non-sampling errors.

Practical

On the topics listed in the theory syllabus.

STAT 602 Advanced Statistical Computing 3(2+1)

Theory

UNIT I

Measures of association. Structural models for discrete data in two or more dimensions.

Estimation in complete tables. Goodness of fit, choice of a model. Generalized Linear Model for discrete data, Poisson and Logistic regression models. Log-linear models.

UNIT II

Elements of inference for cross-classification tables. Models for nominal and ordinal response.

UNIT III

Computational problems and techniques for robust linear regression, nonlinear and generalized linear regression problem, tree-structured regression and classification, cluster analysis, smoothing and function estimation, robust multivariate analysis.

UNIT IV

Analysis of incomplete data: EM algorithm, single and multiple imputations. Markov Chain, Monte Carlo and annealing techniques, Neural Networks, Association Rules and learning algorithms.

Practical

On the topics listed in the theory syllabus.

STAT 603 Simulation Techniques 3(2+1)

Theory

UNIT I

Review of simulation methods; Implementation of simulation methods – for various probability models, and resampling methods: theory and application of the jackknife and the bootstrap.

UNIT II

Correlograms, periodograms, fast Fourier transforms, power spectra, cross-spectra, coherences, ARMA and transfer-function models, spectral-domain regression. Simulated data sets to be analyzed using popular computer software packages

UNIT III

Stochastic simulation: Markov Chain, Monte Carlo, Gibbs' sampling, Hastings-Metropolis algorithms, critical slowing-down and remedies, auxiliary variables, simulated tempering, reversible- jump MCMC and multi-grid methods.

Practical

On the topics listed in the theory syllabus.

STAT 611 Advanced Statistical Methods 2+1

Theory

UNIT I

Ridge regression: Basic form, Use as a selection procedure. Robust regression: Least absolute deviations regression, M-estimators, Least median of squares regression. Nonparametric regression.

UNIT II

Introduction to the theory and applications of generalized linear models, fixed effects, random effects and mixed effects models, estimation of variance components from unbalanced data. Unified theory of least -squares, MINQUE, MIVQUE, REML.

UNIT III

Quasi-likelihoods, and generalized estimating equations - logistic regression, over-dispersion, Poisson regression, log-linear models, conditional likelihoods, generalized mixed models, and regression diagnostics. Theory of statistical methods for analyzing categorical data by means of linear models; multifactor and multi-response situations; interpretation of interactions.

UNIT IV

Fitting of a generalized linear model, mixed model and variance components estimation, MINQUE, MIVQUE, REML.

Practical

On the topics listed in the theory syllabus.

STAT 612 Advanced Statistical Inference 3(2+1)

Theory

UNIT I

Robust estimation and robust tests, Robustness, M-estimates. L-estimates, asymptotic techniques, Bayesian inference. Detection and handling of outliers in statistical data.

UNIT II

Density Estimation: Density Estimation in the Exploration and Presentation of Data. Survey of existing methods. The Kernel method for Univariate Data: Rosenblatts naïve estimator, its bias and variance. Consistency of general Kernel estimators, MSE and IMSE. Asymptotic normality of Kernel estimates of density. Estimation of distribution by method of kernels.

UNIT III

Consistency and asymptotic normality (CAN) of real and vector parameters. Invariance of consistency under continuous transformation. Invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem. Exponential class of densities and multinomial distribution, Cramer-Huzurbazar theorem, method of scoring.

UNIT IV

Efficiency: asymptotic relative efficiency and Pitman's theorem. Concepts and examples of Bahadur efficiency and Hodges-Lehmanns efficiency with examples. The concepts of Rao's second order efficiency and Hodges-Lehmann's Deficiency with examples. Rank tests, permutation tests, asymptotic theory of rank tests under null and alternative (contiguous) hypotheses.

UNIT V

Concept of loss, risk and decision functions, admissible and optimal decision functions, a-priori and posteriori distributions, conjugate families. Bayes and Minimax decision rules and some basic results on them. Estimation and testing viewed as cases of decision problems. Bayes and Minimax decision functions with applications to estimation with quadratic loss function.

Practical

On the topics listed in the theory syllabus.

STAT 613 Advanced Design of Experiments 3(2+1)

Theory

UNIT I

General properties and analysis of block designs. Balancing criteria. *m* -associate PBIB designs, and their association schemes including lattice designs - properties and construction, Designs for test treatment – control(s) comparisons; Nested block designs, Mating designs.

UNIT II

General properties and analysis of two-way heterogeneity designs, Youden type designs, generalized Youden designs, Pseudo Youden designs. Structurally Incomplete block designs, Designs for two sets of treatments.

UNIT III

Balanced factorial experiments - characterization and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal arrays, Mixed orthogonal arrays, balanced arrays, Fractional replication, Regular and irregular fractions.

UNIT IV

Response surface designs - Symmetrical and asymmetrical factorials, Response optimization and slope estimation, Blocking. Canonical analysis and ridge analysis. Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors.

Practical

On the topics listed in the theory syllabus.

STAT 614 Advanced Sampling Techniques 3(2+1)

Theory

UNIT I

Controlled selection. Two way stratification, collapsed strata. Systematic sampling in two dimensions. Use of combinatorics in controlled selection. Integration of surveys - Lahiri and Keyfitz's procedures.

UNIT II

Variance estimation in complex surveys. Taylor's series linearisation, balanced repeated replication, Jackknife and bootstrap methods.

UNIT III

Unified theory of sampling from finite populations. UMV - Non-existence theorem and existence theorem under restricted conditions. Concept of sufficiency and likelihood in survey sampling. Admissibility and hyper-admissibility.

UNIT IV

Inference under super population models - concept of designs and model unbiasedness, prediction approach. Regression analysis and categorical data analysis with data from complex surveys. Domain estimation. Small area estimation.

Practical

On the topics listed in the theory syllabus.

STAT 616 Statistical Modeling 3(2+1)

Theory

UNIT I

Empirical and mechanistic models. Nonlinear growth models like monomolecular, logistic, Gompertz, Richards. Applications in agriculture and fisheries.

UNIT II

Nonlinear estimation: Least squares for nonlinear models, Methods for estimation of parameters like Linearization, Steepest, and Levenberg-Marquardt's Reparameterization.

UNIT III

Two-species systems. Lotka-Volterra, Leslie-Gower and Holling-Tanner non-linear prey-predator models. Volterra's principle and its applications. Gause competition model.

UNIT IV

Compartmental modelling - First and second order input-output systems, Dynamics of a multivariable system.

Practical

On the topics listed in the theory syllabus.

STAT 617 Advanced Time Series Analysis 3(2+1)

Theory

UNIT I

Multivariate time series: modelling the mean, stationary VAR models: properties, estimation, analysis and forecasting, VAR models with elements of nonlinearity, Non-stationary multivariate time series: spurious regression, co-integration, common trends.

UNIT II

Volatility: Modelling the variance, The class of ARCH models: properties, estimation, analysis and forecasting, stochastic volatility, realized volatility, Extensions: IGARCH, ARCH-t, ARCD, Multivariate GARCH, Time-varying risk and ARCH-in-mean.

UNIT III

Structural time-series modelling: State space models, Kalman filter. Local level model, Local linear trend model, Seasonal models, Cyclical models. Nonlinear time-series models: Parametric and nonparametric approaches. Autoregressive conditional heteroscedastic model and its extensions. Threshold and Functional coefficient autoregressive models.

UNIT IV

Non-linear programming, Kuhn-Tucker sufficient conditions, Elements of multiple objective programming, Dynamic Programming, Optimal control theory - Pontryagin's maximum principle, Time-optimal control problems.

Practical

On the topics listed in the theory syllabus.

STAT 618 Stochastic Processes 3(2+1)

Theory

UNIT I

Introduction to stochastic process - classification according to state space and time domain. Finite and countable state Markov chains; time-homogeneity; Chapman-Kolmogorov equations, marginal distribution and finite dimensional distributions. Classification of Markov chain. Canonical form of transition probability matrix of a Markov chain. Fundamental matrix; probabilities of absorption from transient states into recurrent classes in a finite Markov chain, mean time for absorption. Ergodic state and Ergodic chain. Stationary distribution of a Markov chain, existence and evaluation of stationary distribution. Random walk and gamblers ruin problem.

UNIT II

Discrete state continuous time Markov process: Kolmogorov difference –differential equations. Birth and death process, pure birth process (Yule-Fury process). Immigration-Emigration process. Linear growth process, pure death process.

UNIT III

Renewal process: renewal process when time is discrete and continuous. Renewal function and renewal density. Statements of Elementary renewal theorem and Key renewal theorem.

UNIT IV

Stochastic process in biological sciences: Markov models in population genetics, compartmental analysis. Simple deterministic and stochastic epidemic model. General epidemic models-Karmack and McKendrick's threshold theorem. Recurrent epidemics.

UNIT V

Elements of queueing process; the queuing model M/M/1: steady state behaviors. Birth and death process in queuing theory-Multi channel models. Net work of Markovian queuing system.

UNIT VI

Branching process: Galton-Watson branching process. Mean and variance of size of nth generation, probability of ultimate extinction of a branching process. Fundamental theorem of branching process and applications.

Practical

On the topics listed in the theory syllabus.

STAT 619 Survival Analysis 3(2+1)

Theory

UNIT I

Measures of Mortality and Morbidity: Ratios and proportions, rates of continuous process, rates of repetitive events ,crude birth rate, Mortality measures used in vital statistics relationships between crude and age specific rates, standardized mortality ratios, evaluation of person-year of exposed to risk in long term studies, prevalence and incidence of a disease, relative risk and odds ratio.

Survival Distribution: Survival functions, hazard rate, hazard function, review of survival distributions: exponential, Weibull, Gamma, Rayleigh, Pareto, Lognormal~ IFR and TFRA, Gompertz and Makeham. Gompertz and logistic distributions. Parametric (m.l.e) estimation. Types of Censoring: Type I, Type II, random and other types of censoring, right and left truncated distributions. Expectation and variance of future life time, series and parallel system of failures.

Life Tables: Fundamental and construction.

UNIT II

Complete Mortality data, Estimation of Survival Function: Empirical survival function, estimation of survival function from grouped mortality data, joint distribution of the number of deaths, distribution of the estimation P covariance of estimate, estimation of curves of deaths and I central death rate and force of mortality rate .

Incomplete Mortality data (non-parametric models): Actuarial method, m.1.e method, moment and reduced sample method of estimation and their comparison. Product limit (Kaplan-Meier) method and cumulative hazard function (CHF) of estimation of survival function.

UNIT III

Fitting Parametric Survival Distribution : Special form of survival function cumulative hazard function (CHF) plots, Nelson's method of ungrouped data, construction of the likelihood function for survival data, least squares fitting, fitting a Gompertz distribution to grouped data.

Some tests of Goodness of fit: Graphical, Kolmogorov-Smirnov statistics for complete, censored and truncated data, Chi-Square test and Anderson-Darling A^2 -statistics.

Comparison of Mortality Experiences: Comparison of two life tables, some distribution- free methods (two samples) for ungrouped data, Two samples Kolmogorov-Smirnov test, Wilcoxon test for complete data and modified Wilcoxon test for incomplete data .Gilbert and Gehan's test, mean and variance of Wilcoxon statistics, generalization of Gehan's test. Testing for Consistent Differences in Mortality: Mantel-Haenszel and log rank test. Generalized Mantel-Haenszel test (k-sample).

UNIT IV

Concomitant Variables: General parametric model for hazard function with observed concomitant variables. Additive and multiplicative models of hazard rate functions. Estimating multiplicative models, selection of concomitant variables. Logistic linear model, Concomitant Variable regarded as random variable. Age of onset distributions: Models of onset distributions and their estimation.

Gompertz distribution, parallel system and Weibull distribution, Fatal short models of failure. Two component series system.

Practical

On the topics listed in the theory syllabus.

STAT 651 Recent Advances In The Field of Specialization 1(1+0)

Theory

Recent advances in the field of specialization - sample surveys / design of experiments /statistical genetics / statistical modeling / econometrics / statistical inference, etc. will be covered by various speakers from the University / Institute as well as from outside the University / Institute in the form of seminar talks.

2. Agricultural Engineering (Soil & Water Conservation Engineering)

SWE 601 ADVANCED HYDROLOGY 3+0

Objective

To acquaint and equip the students with advanced hydrological process, analysis of hydrological data and their application for modeling. .

Theory

UNIT I

Hydrologic models, processes and systems. Uncertainty in hydrological event. Statistical homogeneity.

UNIT II

Probabilistic concept. Frequency analysis. Co-relation and regression analysis. Probability distribution of hydrological variables.

UNIT III

Systems engineering for water management; Complexity of resources management process, systems analysis.

Time series analysis. Markov processes.

UNIT IV

Formulation of various steps of statistical models and their application in hydrology.

Suggested Readings

Garg SK.1987. *Hydrology and Water Resources Engineering.* Khanna Publ.

Hann CT. *Advanced Hydrology* . Oxford Publ. House.

Linseley RK Jr., Kohler MA & Paulhus JLH. 1975. *Applied Hydrology*. McGraw Hill.

Mutreja KN.1986. *Applied Hydrology* . Tata McGraw Hill.

SWE 602 SOIL AND WATER SYSTEMS' SIMULATION AND MODELLING 2+1

Objective

To acquaint and equip the students with the simulation of soil water systems and modeling techniques.

Theory

UNIT I

Systems engineering for water management; Complexity of resources management process, systems analysis.

UNIT II

Rainfall-runoff models - Infiltration models, Simulation methods, structure of a water balance model.

UNIT III

Channel flow simulation - parameters and calibration - Streamflow statistics, surface water storage requirements.

UNIT IV

Flood control storage capacity; total reservoir capacity. Ground water models.

UNIT V

Design of nodal network, General systems frame work General –Numerical approaches.

Practical

Rainfall - Runoff models - Infiltration models - channel flow simulation problems - stream flow statistics – model parameters and input data requirements of various softwares of surface hydrology and groundwater – Hydrologic Modelling System – Soil Water Management Model – Use of dimensionless unit hydrograph

Suggested Readings

Biswas AK. 1976. *Systems Approach to Water Management* . McGrawHill.

Cox DR & Mille HD. 1965. *The Theory of Stochastic Processes* . John Wiley & Sons.

Eagleson PS. 1970. *Dynamic Hydrology* . McGraw Hill.

Himmel Blau DM & Bischoff KB. 1968. *Process Analysis and Simulation Deterministic Systems* . John Wiley & Sons.

Linsley RK, Kohler MA & Paulhus JLH. 1949. *Applied Hydrology*. McGraw Hill.

Schwar RS & Friedland B. 1965. *Linear Systems* . McGraw Hill.

Ven Te Chow, David R Maidment & Mays LW. 1998. *Applied Hydrology*. McGraw Hill.

SWE 603 MODELLING SOIL EROSION PROCESSES 2+1

Objective

To acquaint and equip the students with the advance erosion process along with tools required and application of soil erosion models.

Theory

UNIT I

Overland flow, basic theory of particle movement and sediment transport; sediment deposition process.

UNIT II

Estimation of sediment load; mechanics of soil erosion by water and wind.

UNIT III

Water and wind erosion control measures.

UNIT IV

Universal soil loss equation; stochastic models and dynamic models.

Practical

Computation of soil erosion index; Estimation of soil erodibility factor; Design of erosion control structures. Computation of suspended load and sediment load using empirical formulae; Application of sediment yield models, prediction of sediment loss – computation of reservoir sedimentation – sounding method.

Suggested Readings

Garde RJ & Ranga Raju KG. 1977. *Mechanics of Sediment Transport and Alluvial Stream Problems*. Wiley Eastern Ltd.

Morgan RPC. (Ed. D. A. Davidson). 1986. *Soil Erosion and Conservation*. ELBS, Longman.

USDA. 1969. *A Manual on Conservation of Soil and Water*. Oxford & IBH.

SWE 604 ADVANCED HYDO-MECHANICS IN SOIL AQUIFER SYSTEMS 3+0

Objective

To acquaint and equip the students with the advance soil-aquifer-water mechanics and various techniques for the analysis of the system

Theory

UNIT I

Soil aquifer system. Flow of water in partially saturated soils. Partial differential equation of flow.

UNIT II

Determination of unsaturated hydraulic conductivity and models for its estimation.

UNIT III

Infiltration and exfiltration from soils in absence and presence of water table. Movement of groundwater in fractured and swelling porous media.

UNIT IV

Spatial variability. Theory of krigging. Statistical approaches in soil water dynamics.

Suggested Readings

Kirkham & Powers.1972. *Advanced Soil Physics* . John Wiley & Sons.

Muskut M.1937. *The Flow of Homogeneous Fluid through Porous Media*. McGraw Hill.

SWE 605 HYDRO-CHEMICAL MODELLING & POLLUTANT MANAGEMENT 3+0

Objective

To acquaint and equip the students with the hydrodynamics of fluid and pollutant flow and the impact analysis of contaminant transport through modeling

Theory

UNIT I

Hydrodynamics in flow through porous media, Hydrodynamic dispersion, diffusion, convection equation.

UNIT II

Analytical and numerical models of contaminant transport in unsaturated soil profile and ground water.

UNIT III

Water quality management in lakes and reservoirs; physical characteristics; hydrologic and chemical budgets; bio-geochemical processes of pollutants; assessment methods.

UNIT IV

Classical wastewater problems; Water reclamation, reuse, water quality constraints and considerations for reuse in irrigation and industry; Biological wastewater treatment.

UNIT V

Modern stream pollution problem. Quality of groundwater and sources of contaminants. Cost economics – environment impact assessment.

Suggested Readings

Larry W Mays 1996. *Water Resources Handbook* . McGraw Hill.

Metcalf and Eddey 1994. *Wastewater Treatment Engineering and Reuse*. John Wiley.

Soli J Arceivala 1998. *Wastewater Treatment for Pollution Control*. Tata McGraw-Hill.

SWE 606 PLANT GROWTH MODELLING AND SIMULATION 3+0

Objective

To acquaint and equip the students with the simulation and modeling techniques in the soil, plant and water environment for crop growth.

Theory

UNIT I

Introduction to crop growth modeling. Simulation and simulation techniques. Types of models and modeling approaches.

UNIT II

Relational diagram for principal process, structures of a generalized agricultural simulator.

UNIT III

Input environment and techniques of monitoring plant environment, process and aspect of growth and development. Input yield models.

UNIT IV

Quantitative analysis of plant processes light photo-syntheses, respiration, growth, water uptake etc. and their mathematical modeling.

Suggested Readings

Loomis RS, Connor DJ.1992. *Crop Ecology: Productivity and Management in Agricultural System.* Cambridge Univ. Press.

Spedding CRW. 1979. *An Introduction to Agricultural Systems*. Applied Science Publ.

Thornley JHM & Johnson IR. 1990. *Plant and Crop Modelling. A Mathematical Approach to Plant and Crop Physiology* . Clarendon Press. Oxford Science Publ.

SWE 607 ADVANCES IN IRRIGATION AND DRAINAGE 2+0

Objective

To acquaint and equip the students with the advance application of irrigation and drainage system along with applicability of various models.

Theory

UNIT I

Advances in surface irrigation systems- surge irrigation: effect of surgingon surface flow hydraulics, cablegation: water supply management.

UNIT II

Atomization in sprinkler and micro irrigation system; multipurpose and special uses of micro irrigation.

UNIT III

Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems.

UNIT IV

Application of simulation models for drainage systems.

Suggested Readings

FAO. 1982. *Mechanized Sprinkler Irrigation* . FAO Irrigation & Drainage Paper 35.

FAO. 1989. *Guidelines for Designing and Evaluating Surface Irrigation System*. FAO Irrigation & Drainage Paper 45.

Keller J & Bliesner RD. 1990. *Sprinkler and Trickle Irrigation*. Chapman & Hall.

Ritzema HP. (Ed.). 1994. *Drainage Principles and Applications* . ILRI.

Walker WR & Skogerboe GV. 1987. *Surface Irrigation: Theory and Practice* . Prentice Hall.

SWE 608 REMOTE SENSING TECHNIQUES FOR NATURAL RESOURCES (2+1)

Objective

To acquaint and equip the students with the techniques of remote sensing in natural resources.

Theory

UNIT I

Basic components of remote sensing, signals, sensors and sensing system; Characteristics of electromagnetic radiation and its interaction with matter;

UNIT II

Data acquisition system and ground truth; Satellite image acquisition; Visual and digital interpretation;

UNIT III

Spectral characteristics of vegetation, soil and water; interpretation; Spectral Characteristics of vegetation, soil and influence of water status;

UNIT IV

Soil moisture assessor; Soil degradation, soil salinity, water logging, soil erosion and conservation.

UNIT V

Land use inventory and planning; Water resource inventory-ground water, water monitoring.

Practical

Practical problems on above topics

Suggested Reading

De Mess MN. 2004. *Fundamental of Geographic Information System* . John Wiley & Sons.
Lille Sand T & Kaiffer R.1987. *Remote Sensing and Image Interpretation.* John Wiley & Sons.
Sabbins F.1987. *Remote Sensing Principle and Interpretation*. Freeman

SWE 609 WATER RESOURCES PLANNING AND MANAGEMENT (2+ 1)

Objective

To acquaint and equip the students with water resources optimization techniques for maximum output.

UNIT I

Introduction artificial ground water recharge; Method of artificial recharge.

UNIT II

Water balance approach in dry farming areas; Conjunctive use of surface and ground water utilization in command areas;

UNIT III

Land use inventory and planning; Water resource inventory-ground water, water monitoring.

UNIT IV

Formulation of resource allocation under constraints to achieve various goals.

Practical

Practical problems on above topics

Suggested Readings

Larry WM. 1996. *Water Resources Handbook* . McGraw-Hill.

Loucks DP *et al.* 1981. *Water Resource System Planning and Analysis*. Prentice Hall.

Rao SS. 1978. *Optimization Theory and Applications* . Wiley Eastern.

3. Agricultural Engineering (Bio Process and Food Engineering)

BPFE-601: Advance Agricultural Processing for Value Addition : 3(2+1)

Introduction to various commonly prevalent value addition practices. Refrigeration a means of value addition commodity storage requirements. Various freezing methods for different value added products. Frozen food storage and their moisture requirements during storage. Aseptic processing systems and thermal process calculations for stabilization of foods for shelf stable storage, sterilization value, thermal death time and use of TDT curve for food stabilization. Extrusion of foods; The food extruder, extrusion models, extrusion measurements and and experimentation. Extrusion equipments extrusion of starch and starchy materials textured plant proteins. Diffusion, extraction and leaching for value addition of foods. Effects of drying on microbiology of stored grains, fungal toxins in grains and seed during storage. Modified atmosphere storage and controlled atmosphere storage for value addition of food products. Role of salt starch, sugar, vitamins, preservatives and antioxidants for value addition. Use of Enzymes and fermentation in food preserving operations.

BPFE-602: *Rheology Chemistry and Physics of Biological Materials:* 3(2+1)

Visco elastic properties of biological materials. Rheology and texture of food materials. Rheological model for visco elastic materials, stress relaxation and creep of biological materials, Maxwells model, Kelvin's model and Burgers Model for visco elastic materials. Mechanical damage and its effect on agricultural materials. Drag coefficient and terminal velocity of biological materials. Impact and restitution in biological materials, various physical properties and their effect on flow properties of biological materials. Chemical characteristics of biological materials responsible for changes during storage and processing. Solubility, hydrolysis, gelatinization, fermentation and rancidity in food materials. Penetration, diffusion, distillation and crystallization. Kinetics of chemical reaction in foods various types of reactions. Enzymatic reactions. Reaction order and reaction rates.

BPFE-603: ***Advance Food Engineering and Technology :*** **3(2+1)**

Size reduction, Cutting. Slicing and Grainding of Food Materials Various size reduction equipments, Various law of size reduction. Mixing, Liquid-Liquid mixing , Liquid-Solid mixing. Evaporation and concentration for value addition. Thermal Processing. Heat Exchangers, Design and its Uses, Pasteurization. Sterilization, Homogenization, Steam and its uses in various thermal Processing operations. Physical separation processes. Filtration, ultra filtration, micro filtration, membrance separation and gravity separatio. Dehydration of Egg. Milk butter, cheese, meat etc. Nutritive value of dehydrated food. Non thermal methods of food preservation. Crystallization, supers saturation, Nucleation, crystal growth, various type of crystallizer, vacuum crystallizer, draft-tube-baffle crystallizer, yield of vacuum crystallizer, mixing.

BPFE-604: ***Advances in Grain Drying:*** **3(2+1)**

Principles of grain drying. Moist air properties. Grain equilibrium moisture content. Concept of rate periods of drying, drying rate. Thin layer and deep bad drying and associated heat transfer principles. Grain drying theory and various grain drying systems. Air movement and air flow requirement for in storage drying. Design methods and methodologies for design of dryers. Viz. RPEC dryer, LSU dryer, Tray dryer, Drum Dryers. Drying for value addition spray drying, freeze drying and OSMOTIC drying. Recent developments is drying and dehydration for quality and life enhance cement of foods.

BPFE-605: ***Storage Technology for Agricultural Produce:*** **3(2+1)**

Introduction to various spoilage mechanisms of grains and seeds in the post harvest echo-systems, the resulting losses and strategies for prevention of stock. In storage respiration, bio heating and moisture migration is grains. Properties of grain responsible for production for heat and carbon dioxide during storage. Effect of various grain stabilization processes on the quality of stored grain. Effect of various storage parameters on viability and vigour of seed. In storage inspection and sampling of grains and seeds methods and means. In storage grain handling. In storage measurement of grain temperature and assessment of aeration requirement. Technology of grain storage in bulk and bags. Design considerations involved. Pressure in storage structures and its effect on flow characteristics of grains and viability of seeds. Influence of drying and storage condition on bio Physico chemical and nutritional quality of grains. Recent developments in grain storage technologies.

BPFE-606: ***Product Processing of Horticultural and Plantation Crops.*** **3(2+1)**

Post harvest equipments, principles and techniques for preservation of foods and vegetables, colds storage, freezing, additives and chemical treatments, dehydration, canning and packaging. Manufacturing methods of major horticultural and plantation crop products such as juices, pickles, jams, jellies, marmalades, squash and purees.

BPFE-607: ***Equipment and Process for Confectionary and Convenience Food*** **3(2+1)**

Equipments and manufacturing process for preparation of bread biscuits, cookies, toasts, buns and chocolates, Manufacture of extruded products such as noodles, licia, macaroni. Manufacture of roasted, popped, frilled and puffed food products and weaning food. Manufacture of cereal based high energy food items such as cakes, pastries and pizzas. Manufacture of soft drinks, ingredients and their effects on quality.

DEPARTMENT OF GENETICS & PLANT BREEDING

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)
B.Sc. (Ag.) Courses		
Core Courses		
GPB-111	Principles of Genetics	3(2+1)
GPB-211	Principles of Plant Breeding	3(2+1)
GPB-311	Breeding of Field / Horticulture Crops	3(2+1)
GPB-321	Principles of Plant Biotechnology	3(2+1)
GPB 322	Principles of Seed Technology	3(2+1)
M.Sc. (Ag.) Courses		
GPB-501	Principles of Genetics	3 (2+1)
GPB-502	Principles of Cytogenetics	3 (2+1)
GPB-503	Principles of Plant Breeding	3 (2+1)
GPB-504	Principles of Quantitative Genetics	3 (2+1)
GPB-508	Cell Biology and Molecular Genetics	3 (2+1)
GPB-509	Biotechnology for Crop Improvement	3 (2+1)
Optional Courses		
GPB-505	Mutagenesis and Mutation Breeding	3(2+1)
GPB-506	Population Genetics	3 (2+1)
GPB-507	Heterosis Breeding	3 (2+1)

GPB-510	Breeding for Biotic and Abiotic Stress Resistance	3 (2+1)
GPB-511	Breeding Cereals, Forages and Sugarcane	3 (2+1)
GPB-512	Breeding Legumes, Oilseeds and Fibre Crops	3 (2+1)
GPB-513	Breeding for Quality Traits	3 (2+1)
GPB-514	Gene Regulation and Expression	2(2+0)
GPB-515	Maintenance Breeding, Concepts of Variety Release and Seed Production	2(1+1)
GPB-516	Germplasm Collection, Exchange and Quarantine	3 (2+1)
GPB-517	Data Base Management, Evaluation and Utilization of PGR	3 (2+1)

Master's Seminar and Research

GPB-550	Master's Coures Seminar	1(1+0)
GPB-560	Master's Research (Thesis)	15(15+0)

Ph.D. Course

GPB-603	Genomics in Plant Breeding	3(2+1)
GPB-604	Molecular and Chromosomal Manipulations for Crop Breeding	2(2+0)
GPB-605	Advances Plant Breeding Systems	2(2+0)
GPB-691	Doctoral Seminar I (RPP non-credit)	

Optional Courses

GPB-601	Plant Genetic Resources and Pre-Breeding	2(2+0)
GPB-602	Advances in Biometrical and Quantitative Genetics	3(2+1)
GPB-606	Crop-Evolution	2(2+0)
GPB-607	Breeding Designer Crops	3(2+1)
GPB-608	Advances in Breeding of Major Field Crops	3(3+0)
GPB-609	Microbial Genetics	3(2+1)
GPB-610	*In-situ* and *ex-situ* Conservation of Germplasm	3(2+1)

Doctoral Research and Seminar

GPB-650	Research Plan Proposal Seminar	0
GPB-651	Doctoral Seminar	1(1+0)
GPB-652	Pre Submission Ph.D. Thesis Seminar	0
GPB-660	Doctoral Research	45

B.Sc. (Ag.) Courses

GPB-111. Principles of Genetics **3 (2+1)**

Mendel's laws of inheritance and exceptions to the laws; Types of gene action, Multiple alleles, Pleiotropism, Penetrance and expressivity; Quantitative traits, Qualitative traits and differences between them; Multiple factor hypothesis; Cytoplasmic inheritance, it's characteristic features and difference between chromosomal and cytoplasmic inheritance; Mutation and it's characteristic features; Methods of inducing mutations and C *l* B technique. Gene expression and differential gene activation; Lac operon and Fine structure of Gene; Ultra structure of cell and cell organelles and their functions; Study of chromosome structure, morphology, number and types, Karyotype and Idiogram; Mitosis and meiosis, their significance and differences between them; DNA and it's structure, function, types, modes of replication and repair. RNA and its structure, function and types; Transcription, Translation, Genetic code and outline of protein synthesis; Crossing over and factors affecting it; Mechanism of crossing over and Cytological proof of crossing over; Linkage, Types of linkage and estimation of linkage; Numerical chromosomal aberrations (Polyploidy) and evolution of different crop species like Cotton, Wheat, Tobacco, Triticale and Brassicas; Structural chromosomal aberrations.

Practical:

Microscopy (Light microscopes and electron microscopes); Preparation and use of fixatives and stains for light microscopy; Preparation of micro slides and identification of various stages of mitosis; Preparation of micro slides and identification of various stages of meiosis; Monohybrid ratio and its modifications; Dihybrid ratio and its modifications; Trihybrid ratio; Chi-square analysis and Interaction of factors; Epistatic factors, Supplementary factors and Duplicate factors; Complementary factors, Additive factors and Inhibitory factors; Linkage – Two point test cross; Linkage – Three point test cross; Induction of polyploidy using colchicines; Induction of chromosomal aberrations using chemicals.

GPB-211. Principles of Plant Breeding **3(2+1)**

Classification of plants, Botanical description, Floral biology, Emasculation and Pollination techniques in cereals, millets, pulses, oil seeds, fibers, plantation crops etc. Aims and objectives of Plant Breeding; Modes of reproduction, Sexual, Asexual, Apomixis and their classification; Significance in plant breeding; Modes of pollination, genetic

consequences, differences between self and cross pollinated crops; Methods of breeding – introduction and acclimatization. Selection, Mass selection Johannson' s pure line theory, genetic basis, pure line selection; Hybridization, Aims and objectives, types of hybridization; Methods of handling of segregating generations, pedigree method, bulk method, back cross method and various modified methods; Incompatibility and male sterility and their utilization in crop improvement; Heterosis, inbreeding depression, various theories of Heterosis, exploitation of hybrid vigour development of inbred lines, single cross and double cross hybrids; Population improvement programmes, recurrent selection, synthetics and composites; Methods of breeding for vegetatively propagated crops; Clonal selection; Mutation breeding; Ploidy breeding; Wide hybridization, significance in crop improvement.

Practical: Botanical description and floral biology; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic plant; Plant Breeder' s kit; Hybridization techniques and precautions to be taken; Floral morphology, selfing, emasculation and crossing techniques; Study of male sterility and incomapribility in field plots; Rice and Sorghum; Maize and Wheat; Bajra and ragi; Sugarcane and coconut; Groundnut, Castor, Safflower and Sesamum; Redgram, Bengalgram and Greengram; Soybean and blackgram; Chillies, Brinjal and Tomato; Bhendi, Onion, Bottle gourd and Ridge gourd; Cotton and Mesta; Jute and Sunhemp

GPB-311. Breeding of Field / Horticulture Crops 3(2+1)

Breeding objectives and important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Hardy-Weinberg Law; Study in respect of origin, distribution of species, wild relatives and forms, Cereals, (rice, wheat, maize, millets, sorghum, bajra, ragi); Pulses (redgram, greengram, blackgram, soybean); Oilseeds (Groundnut, sesame, sunflower, safflower, castor, mustard) etc. Fibers (Cotton, kenaf, roselle, jute) etc. Vegetables (Tomato, bhindi, chilli, cucumbers); Flower crops (Chrysanthemum, rose, galardia, gerbera & marigold); Fruit crops (aonla, guava, mango, custard apple, banana, papaya); Major breeding procedures for development of hybrids / varieties of various crops; Plant Genetic Resources their conservation and utilization in crop improvement; Ideotype concept in crop improvement; Breeding for resistance to biotic and abiotic stresses variability in pathogens and pests; Mechanisms of resistance in plant to pathogens and pest; Genetic basis of adaptability to unfavourable environments; Definition of biometrics, assessment of variability ditive, dominance and epistasis and their differentiation; Genotype x Environment interaction and influence on yield/performance. IPR and its related issues.

Practical: Emasculation and Hybridization techniques; Handling of segregating generations, pedigree methods; Handling of segregating generations, bulk methods; Handling of segregating generations, back cross methods; Field lay out of experiments; Field trials, maintenance of records and registers; Estimation of Heterosis and inbreeding depression; Estimation of Heritability, GCA and SCA; Estimation of variability parameters; Parentage of released varieties/hybrids; Problems on Hardy, Weinberg Law; Study of quality characters; Sources of donors for different characters; Visit to seed production and certification plots; Visit to AICRP trials and programmes; Visit to grow out test plots; Visit to various research stations; Visit to other institutions

4. GPB-321. Principles of Plant Biotechnology **3(2+1)**

Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement: Totipotency and Morphogenesis, Nutritional requirements of *in-vitro* cultures; Techniques of In-vitro cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above i*n-vitro* culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement.

Practical: Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoricsis techniques.

GPB 322 Principles of Seed Technology **3(2+1)**

Introduction to Seed Production, Importance of Seed Production, Seed policy, Seed demand forecasting and planning for certified, foundation and breeder seed production, Deterioration of crop varieties, Factors affecting deterioration and their control; Maintenance of genetic purity during seed production, Seed quality; Definition, Characters of good quality seed, Different classes of seed, Production of nucleus & breeder's seed, Maintenance and multiplication of pre-release and newly released varieties in self and cross-pollinated crops; Seed Production, Foundation and certified seed production in maize (varieties, hybrids, synthetics and composites); Foundation and certified seed production of rice (varieties & hybrids); Foundation and certified seed production of sorghum and bajra (varieties, hybrids, synthetics and composites); Foundation and certified seed production of cotton and sunflower (varieties and hybrids); Foundation and certified seed(varieties and hybrids) production of castor, tomato, brinjal, chillies, bhendi, onion, bottle gourd and ridge gourd; Seed certification, phases of certification, procedure for seed certification, field inspection and field counts etc.; Seed Act and Seed Act enforcement, Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency,

Central and State Seed Testing Laboratories; Duties and powers of seed inspectors, offences and penalties; Seed control order: Seed Control Order 1983, Seed Act 2000 and other issues related to seed quality regulation. Intellectual Property Rights, Patenting, WTO, Plant Breeders Rights, Varietal Identification through Grow–Out Test and Electrophoresis; Seed Drying: Forced air seed drying, principle, properties of air and their effect on seed drying, moisture equilibrium between seed and air, Heated air drying, building requirements, types of air distribution systems for seed drying, selection of crop dryers and systems of heated air drying, recommended temperature and depth of the seeds, management of seed drying, Planning and layout of seed processing plant; Establishment of seed processing plant. Seed processing: air screen machine and its working principle, different upgrading equipments and their use, Establishing a seed testing laboratory. Seed testing procedures for quality assessment, Seed treatment, Importance of seed treatment, types of seed treatment, equipment used for seed treatment (Slurry and Mist–O–matic treater), Seed packing and seed storage, stages of seed storage, factors affecting seed longevity during storage and conditions required for good storage, General principles of seed storage, constructional features for good seed warehouse, measures for pest and disease control, temperature control, Seed marketing, marketing structure, marketing organization, sales generation activities, promotional media, pricing policy; Factors affecting seed marketing.

Practical: Seed sampling principles and procedures; Physical Purity analysis of Field and Horticultural crops; Germination analysis of Field and Horticultural crops; Moisture tests of Field and Horticultural crops; Viability test of Field and Horticultural crops; Seed health test of Field and Horticultural crops; Vigour tests of Field and Horticultural crops; Seed dormancy and breaking methods; Grow out tests and electrophoresis for varietal identification; Visit to Seed production plots of Maize, Sunflower, Bajra, Rice, Sorghum, Cotton, Chillies and Vegetables. (Add or delete crops of the region); Visit to Seed processing plants; Visit to Seed testing laboratories; Visit to Grow out testing farms; Visit to Hybrid Seed Production farms; Varietal identification in seed production plots; Planting ratios, isolation distance, roguing etc

M.Sc. (Ag.) Courses

GP 501 Principles of Genetics 3(2+1)

Theory

UNIT I

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel’s paper, Chromosomal theory of inheritance.

UNIT II

Multiple alleles,Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic

cell genetics, Extra chromosomal inheritance.

UNIT III

Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

UNIT IV

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

UNIT V

Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT VI

Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression.

Gene regulation in eukaryotes, RNA editing.

UNIT VII

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

UNIT VIII

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

UNIT IX

Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts.

UNIT X

Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

Practical

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification - Electrophoresis – basic principles and running of amplified DNA - Extraction of proteins and isozymes – use of *Agrobacterium* mediated method and Biolistic gun; practical demonstrations - Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

GP 502 Principles of Cytogenetics 3(2+1)

Theory

UNIT I

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

UNIT II

Chromosomal theory of inheritance – Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synopsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications.

UNIT III

Structural variation in chromosomes – their cytogenetical consequences, gene mapping and other uses; Deficiencies, duplications, inversions and interchanges; Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids ; Utilization of aneuploids in gene

location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

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UNIT IV

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids –- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with

apomixes.

UNIT V

Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species.

UNIT VI

Fertilization barriers in crop plants at pre and post fertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and *Aloe vera* - Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops -Various methods of staining and preparation of temporary and permanent slides - Pollen germination *in vivo* and *in vitro;* Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture – Morphological observations on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibre assembly – Morphological observations on alloployploids - Morphological observations on aneuploids

- Cytogenetic analysis of interspecific and intergeneric crosses - Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops. -Fluorescent *in situ* hybridization (FISH)- Genome *in situ* hybridization GISH.

GP 503 Principles of Plant Breeding 3(2+1)

Theory

UNIT I

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

UNIT II

Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

UNIT III

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

UNIT IV

Breeding methods in cross pollinated crops; Selection, Response to Selection; Population breeding-mass selection and ear-to-row methods; S_1 and S_2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT V

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.

UNIT VI

Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding.

UNIT VII

Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

UNIT VIII

Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

GP 504 Principles of Quantitative Genetics 3(2+1)

Theory

UNIT I

Mendelian traits Vs polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

UNIT II

Principles of Analysis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D_2 analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

UNIT IV

Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation.

UNIT V

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis.

Practical

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D_2 analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II – Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression - Generation mean analysis: Analytical part and Interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions - Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple

Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model – Principal Component Analysis model - Additive and multiplicative model – Shifted D_1 multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.

GP 505 Mutagenesis and Mutation Breeding 3(2+1)

Objective

To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advances made.

Theory

UNIT I

Mutation and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations - Detection of mutations in lower and higher organisms – paramutations.

UNIT II

Mutagenic agents: physical -- Radiation types and sources: Ionising and non-ionizing radiations *viz*., X rays, γ rays and β particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects –RBE and LET relationships.

UNIT III

Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects - Dosimetry - Objects and methods of treatment - Factors influencing mutation: dose rate, acute Vs. chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: External and internal sources- Oxygen, water content, temperature and nuclear volume.

UNIT IV

Chemical mutagens- Classification - Base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis - Treatment methods using physical and chemical mutagens – Combination treatments; Other causes of mutation - direct and indirect action, comparative evaluation of physical and chemical mutagens.

UNIT V

Observing mutagen effects in M_1 generation: plant injury, lethality, sterility, chimeras *etc*., - Observing mutagen effects in M_2 generation - Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations - – Mutations in traits with continuous variation.

UNIT VI

Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc*. - Individual plant based mutation analysis and working out effectiveness and efficiency in M_3 generation - Comparative evaluation of physical and chemical mutagens for creation of variability in the same species – Case studies.

UNIT VII

Use of mutagens in creating oligogenic and polygenic variations – Case studies - *in vitro* mutagenesis – callus and pollen irradiation; Handling of segregating genrations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement,etc) in different crops- Procedures for micromutations breeding/polygenic mutations- Achievements of mutation breeding- varieties released across the world- Problems associated with mutation breeding.

UNIT VIII

Use of mutagens in genomics, allele mining, TILLING.

Practical

Learning the precautions on handling of mutagens; Dosimetry - Studies of different mutagenic agents: Physical mutagens - Studies of different mutagenic agents: Chemical mutagens - Learning on Radioactivity – Production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards - Monitoring – safety regulations and safe transportation of radioisotopes - Visit to radio isotope laboratory ; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagules at different doses of physical and chemical mutagens - Learning combined mutagenic treatments; Raising the crop for observation - Mutagenic effectiveness and efficiency; Calculating the same from earlier literature - Study of M_1 generation – Parameters to be observed; Study of M_2 generation – Parameters to be observed; Mutation breeding in cereals and pulses – Achievements made and an analysis - Mutation breeding in oilseeds and cotton – Achievements and opportunities - Mutation breeding in forage crops and vegetatively propagated crops; Procedure for detection of mutations for polygenic traits in M_2 and M_3 generations.

GP 506 Population Genetics **3(2+1)**

Theory

UNIT I

Population - Properties of population - Mendelian population – Genetic constitution of a population through time, space, age structure etc. Mating systems - Random mating population - Frequencies of genes and genotypes-Causes of change: population size, differences in fertility and viability, migration and mutation.

UNIT II

Hardy-Weinberg equilibrium - Hardy-Weinberg law - Proof – Applications of the Hardy-Weinberg law - Test of Hardy-Weinberg equilibrium – Mating frequencies - Non-dominance - Codominance - Snyder's ratio, importance and its effect over random mating in succeeding generations.

UNIT III

Multiple alleles - More than one locus - Sex linked genes; Use of gene and genotypic frequencies evaluation in field population level; Interpretations - Changes of gene frequency - Migration – Mutation - Recurrent and nonrecurrent - Selection - Balance between selection and mutation – Selection favouring heterozygotes - Overdominance for fitness.

UNIT IV

Non random mating: selfing –inbreeding coefficient - panmictic index – sibmating - Assortative mating and disassortative mating – Pedigree populations and close inbreeding - Estimation of selection - Estimation of disequilibrium - Estimation of linkage - Correlation between relatives and estimation of F; Effect of inbreeding and sibbing in cross pollinated crops.

UNIT V

Gene substitution and average effects; Breeding value- Genetic drift; Genetic slippage, Co-adapted gene complexes; Homoeostasis- Adapative organization of gene pools, Polymorphism- Balanced and Non-balanced polymorphism, heterozygous advantage- Survival of recessive and deleterious alleles in populations.

Practical

Genetic exercise on probability**;** Estimation of gene frequencies; Exercises on factors affecting gene frequencies; Estimation of average affect of gene substitution and breeding value; Exercises on inbreeding and linkage disequilibrium; Exercises of different mating designs; Estimation of different population parameters from experimental data.

GP 507 Heterosis Breeding **3(2+1)**

Theory

UNIT I

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops.

UNIT II

Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis. UNIT III

Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F_2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of Heterosis – case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

UNIT IV

Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of selfincompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.

UNIT V

Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated' crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.

UNIT VI

Organellar heterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis.

UNIT VII

Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum, pigeonpea and oilseed crops.

Practical

Selection indices and selection differential – Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for Heterosis parameters -Hybrid seed production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

GP 508 Cell Biology and Molecular Genetics 3(2+1)

Theory

UNIT I

Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastidschloro/ chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

UNIT II

Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division.

UNIT III

Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

UNIT IV

Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

Practical

Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method;

Determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.

GP 509 Biotechnology for Crop Improvement 3(2+1)

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II

Tissue culture- History, callus, suspension cultures, cloning; Regeneration Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations (F_2s, back crosses, RILs, NILs and DH).

UNIT IV

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

UNIT V

Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT VII

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VIII

GMOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights

UNIT IX

Bioinformatics & Bioinformatics tools.

UNIT X

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants; observations on the contaminants occurring in media – interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse

and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes.

GP 510 Breeding for Biotic and Abiotic Stress Resistance 3(2+1)

Theory

UNIT I

Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT II

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance - Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies.

UNIT III

Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT IV

Classification of abiotic stresses - Stress inducing factors –moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT V

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

UNIT VI

Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management- Achievements.

Practical

Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level - Phenotypic screening techniques for nematodes and borers; Ways of combating them; Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance; Use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies; Understanding the climatological parameters and predisposal of biotic and a biotic stress factors- ways of combating them.

GP 511 Breeding Cereals, Forages and Sugarcane 3(2+1)

Theory

UNIT I

Rice: Evolution and distribution of species and forms - wild relatives and germplasm; Genetics – cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance *etc.* Hybrid rice breeding- potential and outcome - Aerobic rice, its implications and drought resistance breeding.

UNIT II

Wheat: Evolution and distribution of species and forms - wild relatives and germplasm; cytogenetics and genome relationship; Breeding objectivesyield, quality characters, biotic and abiotic stress resistance, exploitation of heterosis etc; Sorghum: Evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc; Pearl millet:

Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc.

UNIT III

Maize: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc - QPM and Bt maize – strategies and implications - Heterosis breeding attempts taken in Sorghum, Pearl Millet and Maize; Minor millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - Minor millets: breeding objectives yield, quality characters, biotic and abiotic stress resistance etc.

UNIT IV

Sugarcane: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Forage grasses: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance etc., synthetics, composites and apomixes.

UNIT V

Forage legumes: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc -

Tree fodders: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance *etc*, palatability studies.

UNIT VI

Distinguishing features of popular released varieties in Rice and Sorghum - Wheat, Pearl millet, Maize and other millets - Sugarcane, forage grasses and legumes and their application to DUS testing - Maintenance of seed purity - Nucleus and Breeder Seed Production.

Practical

Floral biology – emasculation - pollination techniques ; Study of range of variation for yield and yield components – Study of segregating populations and their evaluation - Trait based screening for stress resistance in crops of importance– Use of descriptors for cataloguing Germplasm maintenance; learning on the Standard Evaluation System (SES) and descriptors; Use of softwares for database management and retrieval.Practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories, learning the practice of value addition; visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

GP 512 Breeding Legumes, Oilseeds and Fibre Crops 3(2+1)

Theory

UNIT I

Pigeonpea: Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship; Morphological and molecular descriptors used for differentiating the accessions; Breeding objectives- yield, quality characters, biotic and abiotic stress *etc* - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

UNIT II

Chickpea: Evolution and distribution of species and forms - Wild relatives and germplasm - cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Protein quality improvement; Conventional and modern plant breeding approaches, progress made - Breeding for anti nutritional factors.

UNIT III

Other pulses: Greengram, blackgram, fieldpea, lentil,, lathyrus, cowpea, lablab, mothbean: Evolution, cytogenetics and genome relationship; Learning the descriptors; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT IV

Groundnut: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Pod and kernel characters; Breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT V

Rapeseed and Mustard: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc; Oil quality – characteristics in different oils; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

UNIT VI

Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc. - Oil quality – characteristics; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

UNIT VII

Other oilseed crops: Sunflower, sesame, safflower, niger: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic

stress; Sunflower: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

UNIT VIII

Castor: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, breeding objectives yield, quality characters, biotic and abiotic stress *etc* - Hybrid breeding in castor – opportunities, constraints and achievements.

UNIT IX

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc; Mesta and minor fibre crops: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT X

Distinguishing features of the released varieties in pulses, oilseeds and cotton; Maintenance of seed purity and seed production.

Practical

Use of descriptors for cataloguing – Floral biology - emasculation – pollination techniques; Study of range of variation for yield and yield components - Study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops; Attempting crosses between blackgram and greengram. Use of descriptors for cataloguing – Floral biology, emasculation, pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor, Cotton: Use of descriptors for cataloguing – Floral biology - Learning on the crosses between different species - Cotton: Study of range of variation for yield and yield components - Study of segregating populations - evaluation - Trait based screening for stress resistance - Cotton fibre quality evaluation – conventional and modern approaches; analysing the lint samples of different species, interspecific and interracial derivatives for fibre quality and interpretation –Development and maintenance of male sterile lines Evaluation of cotton cultures of different species for insect and disease resistance – Learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and resistance parameters – learning the procedures on development of Bt cotton - Visit to Cotton Technology Laboratory and Spinning Mills – Learning on cotton yarn production, its quality evaluation and uses.

GP 513 Breeding For Quality Traits 3(2+1)

Theory

UNIT I

Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, aminoacids and anti-nutritional factors - Nutritional improvement - A human perspective - Breeding for grain quality parameters in rice and its analysis - Golden rice and aromatic rice – Breeding strategies, achievements and application in Indian context - Molecular basis of quality traits and their manipulation in rice - Post harvest manipulation for quality improvement.

UNIT II

Breeding for baking qualities in wheat; Characters to be considered and breeding strategies - Molecular and cytogenetic manipulation for quality improvement in wheat - Breeding for quality improvement in barley and oats.

UNIT III

Breeding for quality improvement in Sorghum and pearl millet; Quality protein maize – Concept and breeding strategies – Breeding for quality improvement in forage crops - Genetic resource management for sustaining nutritive quality in crops.

UNIT IV

Breeding for quality in pulses - Breeding for quality in groundnut, sesame, sunflower and minor oilseeds – Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for

quality improvement in cotton.

UNIT V

Genetic engineering protocols for quality improvement – Achievements made - Value addition in crops; Classification and importance – Nutritional genomics and Second generation transgenics.

Practical

Grain quality evaluation in rice; Correlating ageing and quality improvement in rice - Quality analysis in millets; Estimation of antinutritional factors like tannins in different varieties/hybrids; A comparison - Quality parameters evaluation in wheat; Quality parameters evaluation in pulses - Quality parameters evaluation in oilseeds; Value addition in crop plants ; Post harvest processing of major field crops; Quality improvement in crops through tissue culture techniques; Evaluating the available populations like RIL, NIL etc. for quality improvement using MAS procedures.

GP 514 Gene Regulation And Expression 2(2+0)

Theory

UNIT I

Introduction: Gene regulation-purpose; Process and mechanisms in prokaryotes and eukaryotes; Levels of gene controls.

UNIT II

Coordinated genetic regulation-examples- Anthocyanin and gene families and maize.

UNIT III

Gene expression-Transposons in plant gene expression, Paramutations and imprinting of genes and genomes.

UNIT IV

Transgene expression and gene silencing mechanisms; Regulatory geneshorizontal and vertical homology; Transformation regulatory genes as visible markers.

UNIT V

Eukaryotic transcriptional control; Translational and post-translational regulation; Signal transduction; Stress-induced gene expression.

GP 515 Maintenance Breeding and Concepts of Variety Release and Seed Production 2(1+1)

Theory

UNIT I

Variety Development and Maintenance; Definition- variety, cultivar,extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid,and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and

ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops.

GP 516 Germplasm Collection, Exchange And Quarantine 3(2+1)

Theory

UNIT I

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

UNIT II

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection.

UNIT III

Ethnobotanical aspects of PGR; Crop botany, farming systems, collecting wild relatives of crop plants; Collection and preservation of specimens; Importance and use of herbaria and preparation of herbarium specimens.

UNIT IV

Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica*, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge.

UNIT V

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).

UNIT VI

Detection and identification of pests including use of recent techniques like ELISA, PCR etc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

UNIT VII

Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

Practical

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports, airports to study the quarantine regulations; Techniques for the detection of insects, mites, nematodes, bacteria, weeds, pathogens and viruses on seed and planting materials and salvaging; Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc); Detection of GMOs and GEPs; Study of post-entry quarantine operation, seed treatment and other prophylactic treatments.

GP 517 Data Base Management, Evaluation And Utilization Of PGR 3(2+1)

Theory

UNIT I

Statistical techniques in management of germplasm; Core identification, estimation of sample size during plant explorations, impact of sampling on population structure, sequential sampling for viability estimation; Introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability equations and numograms; Estimation of sample size for storage and viability testing.

UNIT II

Germplasm documentation; Basicsof computer and operating systems; Database management system, use of statistical softwares, pictorial and graphical representation of data; introduction to communication network.

UNIT III

Germplasm management system- global scenario; Genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections; necessity of germplasm evaluation; Predictive methods for identification of useful germplasm; Characterization of germplasm and evaluation procedures including specific traits; Gene markers and their use in PGR management.

UNIT IV

Management and utilization of germplasm collections; Concept of core collection, molecular markers and their use in characterization; Evaluation and utilization of genetic resources; Pre-breeding/ genetic enhancement, utilizing wild species for crop improvement; Harmonizing agrobiodiversity and agricultural development crop diversification participatory plant breeding.

Practical

Basics of computer and operating systems; Identification of useful germplasm, evaluation of crop germplasm; Statistical techniques in management of germplasm- estimation of sample size for storage and viability testing; Evaluation procedure and experimental protocols (designs and their analysis), Assessment of genetic diversity; Techniques of Characterization of germplasm; Molecular markers and their use in characterization.

Ph.D. Course

GP 601 Plant Genetic Resources And Pre-Breeding 2(2+0)

Theory

UNIT I

Historical perspectives and need for PGR conservation; Importance of plant genetic resources; Taxonomical classification of cultivated plants; Gene pool: primary, secondary and tertiary; Centres of origin and global pattern of diversity; Basic genetic resources and transgenes.

UNIT II

Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation.

UNIT III

Germplasm conservation- *in situ, ex situ*, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; Registration of plant genetic resources.

UNIT IV

PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; Seed Act, *sui generis* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.

UNIT V

Journey from wild to domestication; Genetic enhancement- need for genetic enhancement; Genetic enhancement in pre Mendelian era and 21st century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.

UNIT VI

Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression.

UNIT VII

Post-genomic tools for genetic enhancement of germplasm; Prebreeding through chromosome manipulation; Application of biotechnology for Genetic enhancement-Achievements.

UNIT VIII

Utilization of genetic resources, concept of core and mini-core collections, genetic enchancement/Prebreeding for crop improvement including hybrid development.

GP 602 Advances in Biometrical and Quantitative Genetics 3(2+1)

Theory

UNIT I

Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis; Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes;

Designs and Systems; Selection of stable genotypes.

UNIT II

Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Principal Component Analysis.

UNIT III

Additive and multiplicative model - Shifted multiplicative model; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes.

UNIT IV

Genetic architecture of quantitative traits; Conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance – Construction of saturated linkage maps, concept of framework map development; QTL mapping- Strategies for QTL mapping - desired populations, statistical methods; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

Practical

Working out efficiency of selection methods in different populations and interpretation - Biparental mating – use of softwares in analysis and result interpretation - Triallel analysis– use of softwares in analysis and result interpretation - Quadriallel analysis – use of softwares in analysis and result interpretation - Triple Test Cross (TTC) – use of softwares in analysis and result interpretation - Advanced biometrical models for combining ability analysis - Selection of stable genotypes using stability analysis; Models in stability analysis, Additive Main Effect and Multiplicative Interaction (AMMI) model - Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes. Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

GP 603 Genomics in Plant Breeding 3(2+1)

Theory

UNIT I

Introduction to the plant genome- Plant nuclear genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity.

UNIT II

Establishment of plant genome mapping projects - Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci; Approaches to apply Marker Assisted Selection (MAS) in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Map based cloning of plant genes.

UNIT III

Regulation of Plant gene expression - Functional genomics – Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.

UNIT IV

Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics– Genome Comparison Techniques- Classical and advanced approaches.

UNIT V

Detection of Single Nucleotide Polymorphism; TILLING and Eco- TILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping.

UNIT VI

Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical

Chromosome analysis in major field crops - Fluorescence *in situ* hybridization - Comparative genomic hybridization – Comparative analysis of plant genomes using molecular markers – Genetic map construction using molecular markers – Mapping major genes using molecular markers – QTL mapping in plants – Comparison across mapping populations – Understanding the need genetic algorithms in QTL mapping – Plant

Genome Databases – Computational tools to explore plant genome databases – Comparative genomics – Comparison of genome sequences using tools of bioinformatics- Advanced genomic technologies: TILLING and Eco-TILLING – DNA Array Technology – Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics.

GP 604 Molecular And Chromosomal Manipulations For Crop Breeding 2(2+0)

Theory

UNIT I

Organization and structure of genome – Genome size – Organization of organellar genomes – Nuclear DNA organization – Nuclear and Cytoplasmic genome interactions and signal transduction; Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content – C value paradox; Sequence complexity – Introns and Exons – Repetitive sequences – Role of repetitive sequence.

UNIT II

Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, loclalization and mapping of genes/genomic segments; Distant hybridization - Role of polyploids in crop evolution and breeding - auto and allopolyploids.

UNIT III

Applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchangegenetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes-linked marker methods; Duplication - production and use; Inversions and location of genes; B/A chromosome translocations and gene location.

UNIT IV

Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics-methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and non-allelic interactions; Telocentric method of mapping.

UNIT V

Barriers to interspecific and intergeneric hybridization- Behaviour of interspecific and intergeneric crosses; Totipotency of cells – Morphogenesis: *in vivo* and *in vitro* – Meristem culture – anther and pollen culture – ovule, ovary, embryo and endosperm culture – protoplast isolation and culture – protoplast fusion, Different pathways of *in vitro* morphogenesis – organogenesis and somatic embryogenesis; *in vitro* mutant/somaclone selection for biotic and abiotic stresses.

GP 605 Advances In Plant Breeding Systems 2(2+0)

Theory

UNIT I

Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.

UNIT II

Self- incompatability and sterility – Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility - Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility – Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.

UNIT III

Population formation by hybridization - Types of populations – Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.

UNIT IV

Selection in self fertilizing crops; Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations Vs advanced generations); Backcross, polycross and test cross.

UNIT V

Selection in cross fertilizing crops – Polycross and topcross selections, Mass and recurrent selection methods and their modifications – Mass selection: grided mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) - Recurrent selection for general combining ability (GCA) – Concepts and utilization - Recurrent selection for specific combining ability (SCA) – usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.

UNIT VI

Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatability and sterility in plant breeding – case studies; - Fertility restoration in male sterile lines and restorer diversification programmes - Conversion of agronomically ideal genotypes into male steriles – Concepts and breeding strategies; Case studies - Generating new cytonuclear interaction system for diversification of male steriles - Stability of male sterile lines – Environmental influence on sterility– Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic male sterility and its use heterosis breeding - Apomixis and its use in heterosis breeding - Incongruity – Factors influencing incongruity - Methods to overcome incongruity mechanisms.

GP 606 Crop Evolution 2(2+0)

Theory

UNIT I

Origin and evolution of species; Centres of diversity/origin, diffused centres; Time and place of domestication; Patterns of evolution and domestication-examples and Case studies.

UNIT II

Domestication and uniformity – Characteristics of early domestication and changes – Concept of gene pools and crop evolution; Selection and Genetic drift - Consequences.

UNIT III

Speciation and domestication – The process of speciation – Reproductive isolation barriers – Genetic differentiation during speciation – Hybridization - speciation and extinction.

UNIT IV

Exploitation of natural variation – Early attempts to increase variation – Distant hybridization and introgression- Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer into cultivated species, tools and techniques; Validation of transferred genes and their expression; Controlled introgressions.

UNIT V

Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization; Genome organization – Transgenesis in crop evolution – Multifactorial genome – Intragenomic interaction – Intergenomic interaction – Genome introgression.

UNIT VI

Methods to study crop evolution - Contemporary Methods – Based on morphological features – Cytogenetic analysis – Allozyme variations and crop evolution – DNA markers, genome analysis and comparative genomics.

UNIT VII

Evolutionary significance of polyploidy, Evolution of crop plants through ploidy manipulations; polyploids: methods, use of autopolyploids; haploidy-method of production and use; allopolyploids- synthesis of new crops; - Case studies – Cereals – Pulses – Oilseeds – vegetables, Fibre crops - Plantation crops – Forage crops – Tuber crops – Medicinal Plants.

UNIT VIII

Visit to Centres of Crop Diversity within the country.

GPB 607 Breeding Designer Crops 3(2+1)

Theory

UNIT I

Breeding of crop ideotypes; Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds-proteins, vaccines, gums, starch and fats.

UNIT II

Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode; Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement.

UNIT III

Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.

UNIT IV

Breeding for special traits viz. oil, protein, vitamins, amino acids etc.; Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming.

UNIT V

Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management.

Practical

Demonstration of plant responses to stresses through recent techniques; Water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/drought/salt shock proteins.

GP 608 Advances In Breeding Of Major Field Crops 3(3+0)

Theory

UNIT I

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice, Wheat, Maize, Pearlmillet, Sorghum , Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.

UNIT II

Breeding objectives in rice, wheat, maize, pearlmillet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization; Genetics of quantitative and qualitative traits.

UNIT III

Breeding for value addition and resistance to abiotic and biotic stresses.

UNIT IV

Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

UNIT V

National and International accomplishments in genetic improvement of major field crops and their seed production.

GP 609 Microbial Genetics 3(2+1)

Theory

UNIT I

Nature of bacterial variation; Molecular aspects of mutation; Episomes and plasmids; Gene mapping in bacteria; Life cycle of bacteriophages; Genetic fine analysis of rII locus; Circular genetic map of phage T4; Transposable elements; Gene manipulation; Biochemical genetics of *Neurospora and Sacharomyces* ; One gene - one enzyme hypothesis.

UNIT II

Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Molecular chaperones and gene expression; Genetic basis of apoptosis.

UNIT III

Transgenic bacteria and bioethics; genetic basis of nodulation, nitrogen fixation and competition by rhizobia, genetic regulation of nitrogen fixation and quorum sensing in rhizobia; genetics of mitochondria and chloroplasts.

Practical

Preparation and sterilization of liquid and agar bacterial nutrient media; Assessment of generation time in the log-phage bacterial cultures. Handling of microorganisms for genetic experiments; Isolation of rhizobia from nodules; Gram staining of rhizobial cells; Examination of polyhydroxy butyrate (PHB) production in rhizobia; Demonstration of N_2-fixing nodules/bacterial inoculation in the legume- *Rhizobium* symbiotic system. Induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria; determination of spontaneous and induced mutation frequencies; Discrete bacterial colony counts for the preparation of survival curves and determination of LD_{50} of a mutagen.

GPB 610 *In Situ* And *Ex Situ* Conservation Of Germplasm 3(2+1)

Theory

UNIT I

Concept of natural reserves and natural gene banks, *In situ* conservation ofwild species in nature reserves: *in situ* conservation components, factors influencing conservation value, national plan for *in situ* conservation; *in situ* conservation of agro-biodiversity on-farm; scientific basis of *in situ* conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of *in situ* conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

UNIT II

Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, *perma-frost* conservation, guidelines for sending seeds to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling ,clonal repositories, genetic stability under long term storage condition.

UNIT III

In vitro storage, maintanence of *in vitro* culture under different conditions, *in vitro* bank maintanence for temporate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems , prospects of *in vitro* gene bank.

UNIT IV

Cryopreservation- procedure for handling seeds of orthodox and recalcitrants-cryoprotectants,dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agriculture, horticulture and forestry crops.Problems and prospects; challenges aheads.

Practical

In situ conservation of wild species –case studies at national and international levels- *ex situ* techniques for active and long-term conservation of collections- Preparation and handling of materials, packaging, documentation; design of cold storage modules- Conservation protocols for recalcitrant and orthodox seeds; Cytological studies for assessing genetic stability, *in vitro* cultures- embryo,cell/suspension cultures,pollen cultures, study of cryotank facility and vitrification techniques, visit to NBPGR/NBAGR -study using fruit crops and other horticultural crops.

DEPARTMENT OF HORTICULTURE

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)

B.Sc. (Ag.) Courses

Core Courses

HOR-111	Production Technology of Fruit Crops	3(2+1)
HOR-121	Production Technology of Vegetables and Flowers	3(2+1)
HOR- 211	Production Technology of Spices, Aromatic, Medicinal and Plantation Crops	3(2+1)
HOR-311	Post Harvest Management and Value Addition of Fruits and Vegetables	2(1+1)

M.Sc. (Ag). Courses

HOR 501*	Tropical and Dry-land Fruit Production	3(2+1)
HOR 502*	Production Technology of Warm Season Vegetable Crops	3(2+1)
HOR 503*	Landscaping and Ornamental Gardening	3(2+1)
HOR 504*	Breeding of Horticultural Crops	3(2+1)
HOR 505	Production Technology of Cool Season Vegetable Crops	3(2+1)
HOR 506	Sub-tropical and Temperate Fruit Production	3(2+1)
HOR 507	Post harvest Management of Horticultural Crops	3(2+1)
HOR 508	Growth and Development of Horticultural Crops	3(2+1)
HOR 509	Protected Floriculture	3(2+1)
HOR 510	Canopy Management in Fruit Crops	3(2+1)
HOR 512	Production Technology of Cut Flowers	3(2+1)

HOR 513	Production Technology of Medicinal and Aromatic Plants	3(2+1)
HOR 591*	Master's Seminar (Course Seminar)	1(1+0)
HOR 599*	Master's Research	20

Ph. D. Courses

HOR 601**	Advances in Breeding of Fruit and Plantation Crops	3(2+1)
HOR 602**	Advances in Breeding of Vegetable Crops	3(2+1)
HOR 603	Advances in Production of Fruit Crops	3(2+1)
HOR 604	Advances in Production of Vegetable Crops	3(2+1)
HOR 605	Advances in Flower Production Technology	3(2+1)
HOR 606**	Advances in Breeding of Flower Crops	3(2+1)
HOR 607	Biotic and Abiotic Stress Management in Horticultural Crops	3(2+1)
HOR 691**	Doctoral Seminar – I (Synopsis Seminar)	1(1+0)
HOR 692**	Doctoral Seminar – II (Course Seminar)	1(1+0)
HOR 699**	Doctoral Research	45

B.Sc. (Ag.) Courses

HOR-111. Production Technology of Fruit Crops 3(2+1)

Definition and importance of horticulture. Divisions of horticulture. Climatic zones of horticultural crops. Area and production of different fruit crops. Selection of site, fencing, wind break, planting systems, high density planting, planning and establishment. Propagation methods and use of rootstocks. Methods of training and pruning. Use of growth regulators in fruit production. Package of practices for the cultivation of major fruits - mango, banana, citrus, grape, guava. sapota, apple, litchi, papaya and walnut. Minor fruits- pineapple, custard apple, pomegranate, ber, fig, jackfruit, pear, peach and plum.

Practical: Identification of horticultural tools and implements and their uses; containers, potting mixture, potting, repotting and depotting; plant propagation, seed propagation, scarification, and stratification; propagation by cuttings (softwood, semi-

hardwood and hardwood), layering (simple layering, air layering and stooling in guava); orchard layout and planting systems (traditional and high density); Methods of training and pruning; training of ber, grape and pomegranate; pruning of ber, grape, phalsa, fig, apple, peach and pear; identification and description of varieties of mango, guava, grape, papaya, apple and sapota; identification and description of varieties of banana, citrus (lime, lemon, sweet orange, mandarin and grape fruit), pomegranate, bael, ber and pear;iIrrigation methods including drip. Establishment of micro-irrigation system in orchard. Fertilizer application in fruit crops including fertigation. Visit to local commercial orchards; Preparation of growth regulators, powder, solution and lanonlin paste for propagation; application of growth regulators for improving fruit set, fruit size, quality, delaying ripening and hastening ripening.

HOR-121 Production Technology of Vegetables and Flowers 3(2+1)

Importance of Olericulture, vegetable gardens, vegetable classification. Origin, area, production, varieties, package of practices for fruit vegetables- tomato, brinjal, chillies and okra; Cucurbitaceous vegetables- cucumber, bottle gourd, bitter gourd and melons; Cole crops- cabbage and cauliflower; Bulb crops- onion and garlic; Beans and peas- French bean, dolichos beans and peas; Tuber crops- potato and sweet potato; Root crops- carrot and radish; Leafy vegetables- amaranthus and palak; Perennial vegetables- drumstick and coccinia. Importance of floriculture and ornamental gardens. Planning of ornamental gardens. Types and styles of ornamental gardens. Use of trees, shrubs, climbers, palms, foliage, succulents and seasonal flowers in the gardens. Package of practices for rose, jasmine, chrysanthemum, carnation, marigold, tuberose and gladiolus.

Practical: Planning and layout of kitchen garden; identification of important vegetable seeds and plants; raising of vegetable nurseries; identification of ornamental plants (trees, shrubs, climbers, foliage, succulents, palms etc.) and development of garden features; transplanting of vegetable seedlings; layout of lawns and maintenance; seed extraction in tomato and brinjal. Repotting and depotting and maintenance of ornamental plants; visit to commercial vegetable farms; training and pruning of rose (standards, hybrid "T" and scented) and chrysanthemum (pinching and disbudding); planning and layout of gardens and garden designs for public and private areas; intercultural operations in vegetable plots; seed production in vegetable crops; harvest indices of different vegetable crops; grading and packaging of vegetable; prolonging the vase life of cut flowers.

HOR- 211 Production Technology of Spices, Aromatic, Medicinal and Plantation Crops 3(2+1)

Importance and cultivation technology of spices - clove, ginger, turmeric, black pepper, cardamoms, nigella coriander, cumin, fenugreek; aromatic crops- lemon grass, citronella, palmarose, vetiver, geranium, dawana; plantation crops – coconut, arecanut, betelvine, cashew, cocoa, coffee, tea, oilpalm; medicinal plants- dioscoria, rauvolphaa, opium, ocimum, perwinkle, aloe, guggul, belladonna, nuxvomica, *Solamum khasiamum*, senna, plantago, stevia, coleus and acorus.

Practical

Botanical description and identification of medicinal and aromatic plants; identification of spices and plantation crops; propagation techniques in aromatic and spice crops; selection of mother palm and seed nuts in coconut and oil palm; distillation procedures for aromatic crops; propagation methods in plantation crops (tea and coffee); propagation and planting methods in turmeric, ginger and black pepper; harvesting procedures in aromatic plants; processing and curing of spices

(ginger, turmeric and black pepper); training methods in betelvine. Rejuvenation practices in cashewnut; products- byproducts of spices and plantation crops; procedures for oleoresin extraction. Visit to local commercial plantations, aromatic and medicinal plant nurseries and seed spices field.

HOR-311 Post Harvest Management and Value Addition of Fruits and Vegetables 2(1+1)

Importance and scope of post harvest technology in horticultural crops. Maturity indices, harvesting and post harvest handling of fruits and vegetables. Factors responsible for deterioration of harvested fruits and vegetables. Chemicals used for hastening and delaying ripening of fruits and vegetables. Methods of storage- precooling, prestorage treatments, low temperature storage, controlled atmospheric storage, hypobaric storage, irradiation and low cost storage structures. Various methods of packing, packaging materials and transport. Packing technology for export in mango, banana, grapes kinnow, sweet orange and mandarin. Importance and scope of fruit and vegetable preservation in India. Principles of preservation by heat, low temperature, chemicals and fermentation. Preparation of jams, jellies, marmalades, preserves, chutneys, pickles, ketchup, sauce. puree, syrups, juices and squashes. Spoilage of canned products. Preservatives, colours permitted and prohibited in India.

Practical: Practice in judging the maturity of various fruits and vegetables. Conservation of zero energy cool chambers for on farm storage. Determination of physiological loss in weight (PLW), total soluble solids (TSS), total sugars, acidity and ascorbic acid content in fruits and vegetables. Packaging methods and types of packages and importance of ventilation. Pre-cooling and methods of prolonging storage life. Effect of ethylene on ripening of banana, sapota and mango. Identification of equipment and machinery used is preservation of fruits and vegetables. Preservation by drying and dehydration. Preparation of jam, jelly, marmalades, squash and syrups. Preparation of chutneys, pickles, sauces and ketchup. Visit to local processing units, local market yards, cold storage units and packaging industries.

M.Sc. (Ag). Courses

HOR 501 Tropical And Dry Land Fruit Production 3(2+1)

Theory

Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone, nutrient management, water management, fertigation, role of plant growth regulators, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, pest and disease management, physiological disorders- systems, causes and remedies, quality improvement by management practices; maturity indices, harvesting,; industrial and export potential and Agri. Export Zones(AEZ).

Crops

UNIT I: Mango and Banana

UNIT II: Citrus and Papaya

UNIT III: Guava, Sapota and Jackfruit

UNIT IV: Pineapple, Annonas, Avocado and Bael

UNIT V**:** Aonla, Pomegranate, Phalsa and Ber

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing of commercial orchards.

HOR 502 Production Technology Of Warm Season Vegetable Crops 3(2+1)

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, plant protection measures, and seed production of:

UNIT I

Tomato, eggplant, hot and sweet peppers

UNIT II

Okra, beans, cowpea and cluster bean

UNIT III

Cucurbitaceous crops

UNIT IV

Tapioca and sweet potato

UNIT V

Green leafy warm season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments

to demonstrate the role of mineral elements, physiological disorders; plant growth regulators and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Suggested Readings

HOR 503 Landscaping And Ornamental Gardening **3(2+1)**

Theory

UNIT I

Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II

Urban landscaping, Landscaping for specific situations, institutions, industries, residences, hospitals, roadsides, traffic islands, dam sites, IT parks, corporate offices.

UNIT III

Garden plant components, arboretum, shrubbery, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers; Production technology for selected annual ornamental plants.

UNIT IV

Lawns, establishment and maintenance of vertical garden, roof garden, bog garden, sunken garden, rock garden.

UNIT V

Bio-aesthetic planning, eco-tourism, indoor gardening, xeri-scaping, hard-scaping.

Practical

Identification and selection of ornamental plants for landscaping**,** practices in preparing designs for home gardens, institutional gardens, avenue planting, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

HOR 504 Breeding of Horticultural Crops **3(2+1)**

Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, achievements and future thrust in the following selected crops. Issue of patenting, PPVFR act.

Crops

UNIT I : Mango, banana, papaya and grapes

UNIT II:, Citrus and apple

UNIT III: Potato, tomato and brinjal

UNIT IV: Hot & Sweet pepper, okra, cabbage and cauliflower

UNIT V**:** Rose, chrysanthemum, gladiolus and dahlia

Practical

Characterization of germplasm, blossom biology, study of anthesis, selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, paleanological studies, selfing and crossing techniques in horticultural crops; hybrid seed production of horticultural crops in bulk. Screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population; Visit to breeding blocks.

Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.

Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.

Paroda RS & Kalloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Regio*n. FAO.

Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables.*Revised, ICAR.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Rai N & Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publ. Agency.

Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani Publ.

Ray PK. *Fruit Breeding*. Narasa Publ.

Singh BD. 1983. *Plant Breeding*. Kalyani Publ.

Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable Crops*. ICAR.

HOR 505 Production Technology of Cool Season Vegetable Crops 3(2+1)

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Potato

UNIT II

Cole crops: cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels sprout

UNIT III

Root crops: carrot, radish, turnip and beetroot

UNIT IV

Bulb crops: onion and garlic

UNIT V

Peas and freanch bean, cool season green leafy vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth regulators and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.

Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.

Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.

Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.

Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.

Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata McGraw- Hill.

HOR 506 Subtropical And Temperate Fruit Production 3(2+1)

Theory

Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bio-regulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-symptoms, causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, pre-cooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.

Crops

UNIT I: Apple, pear and grapes

UNIT II: Plums, peach, apricot and cherries,

UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT IV: Nuts- walnut and almond

UNIT V: Minor fruits- mangosteen, carambola, bael, fig and jamun

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

HOR 507 Post Harvest Management Of Horticultural Crops 3(2+1)

Theory

UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration and transpiration.

UNIT II

Physiology and biochemistry of ripening and senescence, ethylene evolution and ethylene management, factors leading to post-harvest loss and pre-cooling.

UNIT III

Treatments prior to shipment, viz., chlorination, waxing, chemicals, bio-control agents and natural plant products. Methods of storage, ventilated, refrigerated, MAP, CA storage, zero energy cool chamber, hypobaric storage, spoilage: microbial and bio-chemical, physical injuries and storage disorders.

UNIT IV

Packing methods and transport, principles and methods of preservation, processing and canning. Preparation of fruit juices, beverages, pickles, jam, jellies, candies and tomato products. Value addition and post harvest management of loose and cut flowers.

UNIT V

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, management of processing wastes and food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

HOR 508 Growth And Development of Horticultural Crops 3(2+1)

Theory

UNIT I

Cellular structures and their functions; definition of growth and development, growth analysis and its importance in horticultural crops.

UNIT II

Physiology of dormancy and germination of seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of plant growth regulators, plant growth retardants and inhibitors for various purposes in horticultural crops; Role and mode of action of morphactins, anti-transpirants, anti-auxin, ripening retardant and plant stimulants in horticultural crop.

UNIT III

Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in horticultural crops; apical dominance.

Practical

Preparation of solutions of plant growth regulators and their application; experiments in induction and breaking of dormancy by chemicals; induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, sex modification, reduce flower and fruit drops and improving fruit set in horticultural crops.

HOR 509 Protected Cultivation of Horticultural Crops 3(2 + 1)

Theory

UNIT I

Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade nets, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable crops for protected cultivation: Strawberry, capsicum, tomato, cucumber, rose, gerbera and carnation.

UNIT II

Environment control – management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV

Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, de-shooting, de-blossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V

Harvest indices for domestic and export market: harvesting techniques.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, post-harvest handling, packing methods, project preparation, visit to commercial greenhouses.

HOR 510 Canopy Management In Fruit Crops 2(1+1)

Objective

To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory

UNIT I

Canopy management - importance and advantages; factors affecting canopy development.

UNIT II

Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

UNIT III

Spacing and utilization of land area; Canopy management through rootstock and scion, training and pruning and management practices.

UNIT IV

Canopy development and management in relation to growth, flowering, fruiting and fruit quality in apple, peach, pear, grapes, mango, sapota, guava and ber.

Practical

Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

HOR 511 Systematics of Vegetable Crops 2(1+1)

Theory

UNIT I

Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops.

UNIT II

Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering summer vegetables (tomato, brinjal, chilli and cucumber) and winter vegetables (cauliflower, cabbage, peas and beans).

UNIT III

Cytology and descriptive keys of above vegetables.

UNIT IV

Molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description, classification and maintenance of vegetable species and varieties; survey, collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

HOR 512 Production Technologies of Cut Flowers 3(2+1)

Theory

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT III

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, dahlia, gypsophilla, statice, cut foliages and fillers.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

HOR 513 Production Technologies For Medicinal And Aromatic Crops 3(2+1)

Objective

To impart comprehensive knowledge about the production technology of medicinal and aromatic crops.

Theory

UNIT I

Export and import status, Indian system of use of medicinal plant, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production.

UNIT II

Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, *Dioscorea* sp., *Aloe vera*, *Andrographis paniculata.*

UNIT III

Production technology for Isabgol, Poppy, Safed musli, *Stevia rebaudiana, Ocimum sp.*

UNIT IV

Post harvest handling of above mentioned medicinal plants and herbal products and phytochemical extraction techniques.

UNIT V

Aromatic industry, Indian perfumery industry, History, Advancements in perfume industry.

UNIT VI

Production technology for palmarosa, lemongrass, citronella, geranium, artemisia, mentha, patchouli, lavender.

UNIT VII

Post-harvest handling of above mentioned aromatic crops.

Practical

Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Visit to herbal extraction units. Extraction of Essential oils, Project preparation for commercially important aromatic crops, Visit to distillation and value addition units.

Ph. D. Courses

HOR 601 Advances In Breeding of Fruit And Plantation Crops 3(2+1)

Theory

Introduction, adaptation and domestication, Genetic resources, cytogenetics, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility and sterility systems in fruits, recent advances in crop improvement efforts- introduction and selection, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, modern approaches in improvement of fruit crops.

Crops

UNIT I: Mango and banana

UNIT II: Papaya and grapes

UNIT III: Guava and sapota

UNIT IV: Cashew nut and coconut

UNIT V**:** Apple and pear

Practical

Description and cataloguing of germplasm, pollen viability tests, pollen germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagens and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques.

HOR 602 Advances In Breeding of Vegetable Crops 3(2+1)

Theory

Evolution, distribution, cytogenetics, genetic resources, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, ideo type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality; breeding for biotic and abiotic stresses of:

UNIT I

Tomato, brinjal, chilli and potato

UNIT II

Cucumber, Cabbage, cauliflower and melons

UNIT III

Okra, onion, peas and beans

UNIT IV

Carrot and radish

UNIT V

Sweetpotato, elephant foot and yam

Practical

Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease resistance, estimation of quality and processing characters, screening for-quality improvement, estimation of heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

HOR 603 Advances In Production of Fruit And Plantation Crops 3(2+1)

Theory

National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM):

Crops

UNIT I : Mango and banana

UNIT II: Papaya, grapes and citrus

UNIT III: Guava, pomegranate and litchi

UNIT IV: Pineapple, cashew nut and coconut

UNIT V**:** Apple, pear and peach

Practical

Survey of cropping systems and development of high density orchard, Estimating nutrient deficiency- modern methods of irrigation and quality analysis of fruits, use of plant growth regulators and micro-nutrient in plant growth regulation

HOR 604 Advances In Vegetable Production 3(2+1)

Theory

Present status and prospects of integrated vegetable cultivation; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic and inorganic sources of nutrients and management of different cropping systems; containerized culture, year round vegetable production; low cost polyhouse; net house production; organic gardening; vegetable production for nutraceutical, export and processing of:

UNIT I

Tomato, brinjal, chilli and potato

UNIT II

Cucumber, melons, cabbage and cauliflower

UNIT III

Okra, onion, peas and beans

UNIT IV

Carrot, beet root and radish

UNIT V

Sweet potato and tapioca

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; diagnosis of nutritional and physiological disorders; use of plant growth regulators; practices in herbicide application; maturity indices; quality analysis ; marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

HOR 605 Advances In Flower Production Technology 3(2+1)

Theory

UNIT I

Commercial flower production; importance and scope; Global Scenario in cut flower production and trade, Standards for nutritional and global trends, cut flower, loose flowers, dry flowers and floral oil trade.

UNIT II

IPR issues related to planting materials; Greenhouse cultivation techniques; influence of environmental parameters, light, temperature, moisture and CO2 on growth and flowering; regulation for quality flowers.

UNIT III

Harvest indices; Harvesting techniques; Post-harvest handling; Export potential; Agri Export Zones.

UNIT IV

Advance practices in crops like rose, anthurium, orchids, carnation, gerbera, liliums, bird of paradise, *Jasminum* sp.

UNIT V

Floral oil industry, floral concrete production, extraction methods in crops like rose, tuberose, jasminum.

Practical

Greenhouse management; Soil decontamination; Microirrigation; fertigation. Special practices- Pinching, netting, disbudding, defoliation and chemical pruning; Photoperiodic and chemical induction of flowering; Post-harvest handling; Preparation of floral decoratives; visit to commercial cut flower units and extraction units.

HOR 606 Advances In Breeding of Flower Crops **3(2+1)**

Objective

To update knowledge on the recent research trends in the field of breeding of flower crops with special emphasis on crops grown in India.

Theory

UNIT I

Origin of flower crops, Genetic resources, improvement by introduction, selection, and hybridization, Inheritance of important characters, Genetic mechanisms associated with flower colour and flower size, doubleness, fragrance and post-harvest life.

UNIT II

Specific objectives of breeding in flower crops, Methods of breeding suited to seed and vegetatively propagated flower crops, Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility-Incompatibility problems, *Invitro* breeding.

UNIT III

Breeding for resistance to biotic and abiotic stresses in flower crops.

UNIT IV

Specific breeding problems and achievements made in rose, jasmine, chrysanthemum, marigold, tuberose, dahlia gladioli, orchids and aster.

Practical

Identification of crops and commercial cultivars; floral biology, selfing and crossing, Induction of mutants using physical and chemical mutagens; Induction of polyploidy; Screening of plants for biotic and abiotic stresses.

HOR 607 Biotic And Abiotic Stress Management In Horticultural Crops 3(2+1)

Theory

UNIT I

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, pollution - increased level of CO2, industrial wastes, ion toxicity, heavy metals).

UNIT II

Impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations, assessing the stress through remote sensing,.

UNIT III

Greenhouse effect and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mulching, hydrophilic polymers, mode of action and practical use, HSP inducers in stress management.

UNIT IV

Rain water harvesting, increasing water use efficiency, IPM & IDM, use of biocontrol and botanical bioagents.

Practical

Seed treatment, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), chlorophyll, chlorophyll stability index, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, use of anti-transpirant, mulching, bio-control agents, visit to orchards and water shed locations.

DEPARTMENT OF MYCOLOGY AND PLANT PATHOLOGY

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)
B.Sc. (Ag.) Courses		
Core Courses		
MPP-111	Plant Pathogens and Principales of Plant Pathology	**4(3+1)**
MPP -121	Agricultural Microbiology	**3(2+1)**
MPP -221	Diseases of Field Crops and their Management	**3(2+1)**
MPP -311	Diseases of Horticultural Crops and their Management	**3(2+1)**
M.Sc. (Ag). Courses		
MPP 501*	MYCOLOGY	3(2+1)
MPP 502*	PLANT VIROLOGY	3(2+1)
MPP 503*	PLANT BACTERIOLOGY	3(2+1)
MPP 504*	PRINCIPLES OF PLANT PATHOLOGY	3(3+0)
MPP 505*	DETECTION AND DIAGNOSIS OF PLANT DISEASES	2(0+2)
MPP 506*	PRINCIPLES OF PLANT DISEASE MANAGEMENT	3(2+1)
MPP 501*	MYCOLOGY	3(2+1)
MPP 502*	PLANT VIROLOGY	3(2+1)
MPP 503*	PLANT BACTERIOLOGY	3(2+1)
MPP 507	DISEASES OF FIELD AND MEDICINAL CROPS	3(2+1)
MPP 508	DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS	3(2+1)
MPP 509	DISEASES OF VEGETABLE AND SPICES CROPS	3(2+1)
MPP 510	SEED HEALTH TECHNOLOGY	3(2+1)

MPP 511	CHEMICALS IN PLANT DISEASE MANAGEMENT	3(2+1)
MPP 512	ECOLOGY OF SOIL-BORNE PLANT PATHOGENS	3(2+1)
MPP 513	DISEASE RESISTANCE IN PLANTS	2(2+0)
MPP 514/ ENT 514	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	2(1+1)
MPP 515	BIOLOGICAL CONTROL OF PLANT DISEASES	3(2+1)
MPP 516	INTEGRATED DISEASE MANAGEMENT	3(2+1)
MPP 517	MUSHROOM PRODUCTION TECHNOLOGY	3(2+1)
MPP 518	EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES	3(2+1)
MPP 519	POST HARVEST DISEASES	3(2+1)
MPP 520/ ENT 520	PLANT QUARANTINE	2(2+0)
MPP 591*	MASTER'S SEMINAR	1(1+0)
MPP 599*	MASTER'S RESEARCH	20

Ph.D. Courses

MPP 601**	ADVANCED MYCOLOGY	3(2+1)
MPP 602	ADVANCED VIROLOGY	3(2+1)
MPP 603	ADVANCED BACTERIOLOGY	3(2+1)
MPP 604**	MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION	3(2+1)
MPP 605	PRINCIPLES AND PROCEDURES OF CERTIFICATION	1(1+0)
MPP 606	PLANT BIOSECURITY AND BIOSAFETY	2(2+0)
MPP 651**	SYNOPSIS SEMINAR	US/S
MPP 691 **	DOCTORAL SEMINAR I	1(1+0)
MPP 692 **	DOCTORAL SEMINAR II	1(1+0)
MPP 652**	PRE SUBMISSION SEMINAR	US/S
MPP 699 **	DOCTORAL RESEARCH	45

B.Sc. (Ag.) Courses

MPP – 111 Plant Pathogens and Principles of Plant Pathology 4 (3 + 1)

Introduction, Important plant pathogenic organisms, different groups, fungi, bacteria, fastidious vascular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae and phanerogamic parasites with examples of diseases caused by them. Prokaryotes: bacteria:classification of bacteria according to Bergey's Manual of Systematic Bacteriology. General Characters of fungi, Definition of fungus, somatic structures, types of fungal thalli, modifications of thallus, reproduction in fungi (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions and sub-divisions. Introduction: Definition and objectives of Plant Pathology. History of Plant Pathology. Terms and concepts in Plant Pathology. Survival and Dispersal of Plant Pathogens. Phenomenon of infection-pre-penetration, penetration and post penetration. Pathogenesis – Role of enzymes, toxins, growth regulators. Defense mechanism in plants- Structural and Bio-chemical (pre and post infection). Plant disease epidemiology. Plant Disease Forecasting – Remote sensing – General principles of plants disease management – Importance, General Principles - Avoidance, exclusion, protection- Plant Quarantine and Inspection – Quarantine Rules and Regulations. Cultural methods – Rouging, eradication of alternate and collateral hosts, crop rotation, manure and fertilizer management, mixed cropping, sanitation, hot weather ploughing, soil amendments, time of sowing, seed rate and plant density, irrigation and drainage, Role and mechanisms of biological control and PGPR. Physical Methods – Heat and Chemical methods – Methods of application of fungicides. Host plant resistance – Application of biotechnology in plant disease management – Development of disease resistant transgenic plants through gene cloning. Integrated plant disease management (IDM) – Concept, advantages and importance.

Practical: Acquaintance to plant pathology laboratory and equipments; Preparation of culture media for fungi and bacteria; Isolation techniques, preservation of disease samples; Study of *Pythium, Phytophthora* and *Albugo*; Study of *Sclerospora, Peronosclerospora, Pseudoperonospora, Peronospora, Plasmopara* and *Bremia*: Study of genera *Mucor* and *Rhizopus*. Study of *Oidium, Oidiopsis, Ovulariopsis, Erysiphe, Phyllactinia, Uncinula* and *Podosphaera*; Study of *Puccinia* (different stages), *Uromyces*, Study of *Sphacelotheca, Ustilago* and *Tolyposporium* ; Study of *Agaricus, Pleurotus* and *Ganoderma*; Study of *Septoria, Colletotrichum, Pestalotiopsis* and *Pyricularia*; Study of *Aspergillus, Penicillium, Trichoderma*, and *Fusarium*; Study of *Drechslera, Alternaria, Stemphyllium, Cercospora, Phaeoisariopsis, Rhizoctonia* and *Sclerotium,* Demonstration of Koch's postulates; Study of different groups of fungicides and antibiotics; Preparation of fungicides – Bordeaux mixture, Bordeaux paste, Chestnut compound; Methods of application of fungicides- seed, soil and foliar; Bio-assay of fungicides – poisoned food technique, inhibition zone technique and slide germination technique; Bio-control of plant pathogens – dual culture technique, seed treatment . Visit to quarantine station and remote sensing laboratory.

MPP-121 Agricultural Microbiology 3(2+1)

History of Microbiology : Spontaneous generation theory , Role of microbes in fermentation, Germ theory of disease, Protection against infections. Applied areas of Microbiology, Metabolism in bacteria : ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation. Bacteriophages: structure and properties of Bacterial viruses – Lytic and Lysogenic cycle : viroids, prions. Bacterial genetics; Gene expression; Genetic recombination: transformation, conjugation and transduction, Plasmids, episomes, genetically modified organisms. Soil Microbiology: Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere, microflora in composting . Microbiology of water, food & milk. Microbial spoilage and principles of food preservation. Beneficial microorganisms in agriculture: Biofertilizer (Baterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases, Biogas production , Biodegradable plastics, Plant – Microbe interactions.

Practical: General instructions and familiarization with instruments, materials, glassware etc. in a microbiology laboratory: Practice of aseptic methods: I – Evaluation of aseptic technique with a Nutrient broth tube. II-Evaluation of aseptic technique with a Nutrient agar plate. Methods of Sterilization and preparation of media: I – Preparation of nutrient broth, nutrient agar plates, nutrient agar slant and nutrient agar stabbing; II- Sterilization of glassware by Dry heating ; III – Sterilization of nutrient broth by filtration. Plating methods for isolation and purification of bacteria : I – Isolation of bacteria by streak plate method. II – Isolation of aerobic spore forming bacteria by enrichment using Streak plate method, III – Checking of purity of a bacterial culture by Streak plating method. Identification of bacteria by staining methods and Biochemical tests: I-Morphological examination of bacteria by Simple and Differential staining, II – Different biochemical tests for identification of bacterial culture; Enumeration of bacteria: I – Enumeration of bacteria by stain slide method, II-Enumeration of bacteria by most probable number method, III – Enumeration of bacteria by Pour plate method and Spread plate method.

MPP-221 Diseases of Field Crops and Their Management 3(2+1)

Economic importance, symptoms, cause, epidemiology, disease cycle and integrated management of diseases of rice, sorghum, bajra, maize, wheat, sugarcane, turmeric, tobacco, groundnut, sesamum, sunflower, cotton, redgram, bengalgram, blackgram, greengram, tea, soybean.

Practical: Study of symptoms, etiology, host-parasite relationship and specific control measures of the following crop diseases. Preservation of disease samples, survey and collection of Diseases of rice, sorghum; Diseases of wheat , bajra, & maize; Diseases of sugarcane, turmeric & tobacco; Diseases of groundnut, castor & sunflower ; Diseases of sesamum & cotton ; Diseases of redgram, greengram, blackgram, bengalgram & beans; Field visits at appropriate time during the semester.

Note: Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester.

MPP-311 Diseases of Horticultural Crops and Their Management 3(2+1)

Economic Importance, symptoms, cause, disease cycle and integrated management of diseases of : citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, apple, chilli, brinjal, bhendi, potato, crucifers, cucurbits , tomato, beans, onion, coconut , oil palm, betelvine, mulberry, coffee, tea, rose, chrysanthemum and jasmine.

Practical: Diseases of beans, phaseolus, soyabean, Fababean, Urd and mung, citrus, guava, and sapota; Diseases of papaya, , banana, pomegranate & ber ; Diseases of mango, grape & apple; Diseases of chilli, brinjal & Bhendi; Diseases of potato, tomato & crucifers; Diseases of cucurbits, onion & betelvine; Diseases of oil palm, coconut, tea, coffee & mulberry; Diseases of rose, chrysanthemum and jasmine. Field visits at appropriate time during the semester.

M.Sc. (Ag). Courses

MPP -501 Mycology 3(2+1)

Theory

UNIT I

Introduction, definition of different terms, basic concepts.

UNIT II

Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology.

UNIT III

Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.

UNIT IV

The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens: types and importance, fungal genetics and variability in fungi.

Practical

Detailed comparative study of different groups of fungi; collection, identification and preservation of specimens. Isolation and identification of plant pathogenic fungi.

MPP-502 Plant Virology 3(2+1)

Theory

UNIT I History of plant viruses, composition and structure of viruses.

UNIT II Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host-virus interaction, virus-vector relationship.

UNIT III Virus nomenclature and classification, genome organization, replication and movement of viruses.

UNIT IV Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.

UNIT V Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome.

UNIT VI Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

Practical

Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, purification, method of raising antisera, serological tests, electron microscopy and ultratomy, PCR.

MPP-503 Plant Bacteriology 3(2+1)

Theory

UNIT I History and introduction to phytopathogenic prokarya, viz., bacteria, MLOs, spiroplasmas and other fastidious prokarya. Importance of phytopathogenic bacteria.

UNIT II Evolution, classification and nomenclature of phytopathogenic prokarya and important diseases caused by them.

UNIT III Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic prokarya.

UNIT IV General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios.

UNIT V Prokaryotic inhibitors and their mode of action against phytopathogenic bacteria.

UNIT VI Survival and dissemination of phytopathogenic bacteria.

Practical

Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical and serological characterization, isolation of plasmid and use of antibacterial chemicals/antibiotics.

MPP-504 Principles of Plant Pathology 3(3+0)

Theory

UNIT I Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

UNIT II Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

UNIT III Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

UNIT IV Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

UNIT V Disease management strategies.

MPP-505 Detection And Diagnosis of Plant Diseases 2(0+2)

Practical

UNIT I Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.

UNIT II Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.

UNIT III Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron

microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides, etc.; field experiments, data collection and preparation of references.

MPP-506 Principles of Plant Disease Management 3(2+1)

Theory

UNIT I Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanical methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management.

UNIT II Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.

UNIT III History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

Practical

In vitro and *in vivo* evaluation of chemicals against plant pathogens; ED and MIC values, study of structural details of sprayers and dusters.

MPP-507 Diseases of Field And Medicinal Crops 3(2+1)

Theory

UNIT I

Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize.

UNIT II

Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean.

UNIT III

Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.

UNIT IV

Diseases of Cash crops- cotton, sugarcane.

UNIV V

Diseases of Fodder legume crops- berseem, oats, guar, lucerne, cowpea.

UNIT VI

Medicinal crops- plantago, liquorice, *mullathi,* rosagrass, sacred basil, mentha, *ashwagandha*, *Aloe vera*.

Practical

Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops.

MPP-508 Diseases of Fruits, Plantation And Ornamental Crops 3(2+1)

Theory

UNIT I Introduction, symptoms and etiology of different fruit diseases. Factors affecting disease development in fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond, strawberry, citrus, mango, grapes, guava, *ber,* banana, pineapple, papaya, fig, pomegranate, date palm and management of the fruits diseases.

UNIT II Symptoms, mode of perpetuation of diseases of plantation crops such as tea, coffee, rubber and coconut and their management.

UNIT III Symptoms and life cycle of pathogens. Factors affecting disease development of ornamental plants such as roses, gladiolus, tulip, carnation, orchids, marigold, chrysanthemum and their management.

Practical

Detailed study of symptoms and host parasite relationship of representative diseases of plantation crops. Collection and dry preservation of diseased specimens of important crops.

MPP-509 Diseases of Vegetable And Spices Crops 3(2+1)

Theory

UNIT I Nature, prevalence, factors affecting disease development of bulb, leafy vegetable, crucifers, cucurbits and solanaceaous vegetables. Diseases of protected cultivation.

UNIT II Symptoms and management of diseases of different root, bulb, leafy vegetables, crucifers, cucurbits and solanaceaous vegetable crops.

UNIT III Symptoms, epidemiology and management of diseases of different spice crops such as black pepper, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger.

Practical

Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops.

MPP-510 Seed Health Technology 3(2+1)

Theory

UNIT I History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT II Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT III Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT IV Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Practical
Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses. Relationship between seed-borne infection and expression of the disease in the field.

MPP-511 Chemicals In Plant Disease Management 3(2+1)

Theory
UNIT I
History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals.
UNIT II
Classification of chemicals used in plant disease control and their characteristics.
UNIT III
Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals.
UNIT IV
Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of fungicides.
UNIT V
Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides.
UNIT VI
General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.

Practical
Acquaintance with formulation of different fungicides and plant protection appliances. Formulation of fungicides, bactericides and nematicides; *in vitro* evaluation techniques, preparation of different concentrations of chemicals including botanical pesticides based on active ingredients against pathogens; persistence, compatibility with other agro-chemicals; detection of naturally occurring fungicide resistant mutants of pathogen; methods of application of chemicals.

MPP-512 Ecology of Soil-Borne Plant Pathogens 3(2+1)

Theory
UNIT I Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi. Types of biocontrol agents. UNIT II Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis.
UNIT III Suppressive soils, biological control- concepts and potentialities for managing soil borne pathogens.
Practical
Quantification of rhizosphere and rhizoplane microflora with special emphasis on pathogens; pathogenicity test by soil and root inoculation techniques, correlation between inoculum density of test pathogens and disease incidence, demonstration of fungistasis in natural soils; suppression of test soil-borne pathogens by antagonistic

microorganisms. Isolation and identification of different biocontrol agents.

MPP-513 Disease Resistance In Plants 2(2+0)

Theory

UNIT I

Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminology.

UNIT II

Disease escapes, disease tolerance, disease resistance, types of resistance,identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

UNIT III

Host defence system, morphological and anatomical resistance, preformed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms.

UNIT IV

Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

MPP-514/ ENT-514 Insect Vectors of Plant Viruses And Other Pathogens 2(1+1)

Theory

UNIT I History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

UNIT II Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

UNIT III Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

UNIT IV Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

UNIT V Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

Practical

Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies.

MPP-515 Biological Control of Plant Diseases 3(2+1)

Theory

UNIT I Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

UNIT II Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

UNIT III Factors governing biological control, role of physical environment, agroecosystem, operational

mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases. Compatibility of different bioagents.
UNIT IV Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.

Practical
Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, application of antagonists against pathogen *in vitro & in vivo* conditions. Study of cfu/g.

MPP-516 Integrated Disease Management 3(2+1)

Theory
UNIT I Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.
UNIT II Development of IDM- basic principles, biological, chemical and cultural disease management.
UNIT III IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed-mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.

Practical
Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

MPP-517 Mushroom Production Technology 3(2+1)

Theory
UNIT I Historical development of mushroom cultivation and present status, taxonomy, classification, food, medicinal value, uses of mushroom, edible and poisonous mushrooms.
UNIT II Life cycle of cultivated mushrooms, reproduction and strain improvement, maintenance of pure culture, preparation of spawn and facilities required for establishing commercial spawn lab.
UNIT III Preparation of substrate for mushroom cultivation, long, short and indoor composting methods, formulae for different composts and their computation, qualities and testing of compost, uses of spent mushroom compost/substrate.
UNIT IV Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO_2, ventilation in cropping rooms, cultivation technology of *Agaricus bisporus, Pleurotus* sp*., Calocybe indica, Lentinus edodes* and *Ganoderma lucidum.*
UNIT V Insect pests, diseases and abnormalities of cultivated mushroom and their management, post harvest processing and value addition, economics of mushroom cultivation, biotechnology and mushroom cultivation.

Practical
Preparation of spawn, compost, spawning, casing, harvesting and postharvest handling of edible mushroom; identification of various pathogens, competitors of various mushroom.

MPP-518 Epidemiology And Forecasting of Plant Diseases 3(2+1)

Theory
UNIT I Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis.
UNIT II Common and natural logarithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.
UNIT III Survey, surveillance and vigilance, crop loss assessment and models.
UNIT IV Principles and pre-requisites of forecasting, systems and factors affecting various components of forecastings, some early forecasting, procedures based on weather and inoculum potential, modeling disease growth and disease prediction.

Practical
Measuring diseases, spore dispersal and trapping, weather recording, survey, multiplication of inoculum, computerized data analysis, function fitting, model preparation and validation.

MPP-519 Post Harvest Diseases 3(2+1)

Theory
UNIT I Concept of post harvest diseases, definitions, importance with reference to environment and health, principles of plant disease management as pre-harvest and post-harvest, merits and demerits of biological/phytoextracts in controlling post-harvest diseases.
UNIT II Types of post harvest problems both by biotic and abiotic causes, rhizosphere colonization, competitive, saprophytic ability, antibiosis, induced resistance, microbial associations, concept, operational mechanisms and its relevance in control.
UNIT III Factors governing post harvest problems both as biotic and abiotic, role of physical environment, agro-ecocystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens, pathogens and antagonist and their relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases, comparative approaches to control of plant pathogens by resident and introduced antagonists. Isolation, characterization and maintenance of pathogens, role of different storage conditions.
UNIT IV Integrated approach in controlling diseases and improving the shelf life of produce, control of aflatoxigenic and mycotoxigenic fungi, application and monitoring for any health hazard, knowledge of Codex Alimentarious for each product and commodity.

Practical
Isolation, characterization and maintenance of pathogens, role of different storage conditions on disease development, application of antagonists against pathogens *in vivo* and *in vitro* conditions. Comparative efficacy of

different chemicals, fungicides, phytoextracts and bioagents.

MPP-520 /ENT-520 Plant Quarantine 2(2+0)

Theory

UNIT I Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

UNIT II Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT III Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

UNIT IV WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Ph.D. Courses

MPP-601 Advanced Mycology (2+1)

Theory

UNIT I General introduction, historical development and advances in mycology.

UNIT II Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical (Computer based assessment) taxonomy.

UNIT III Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti. Morphology and reproduction of representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi.

UNIT IV Population biology, pathogenic variability/vegetative compatibility.

UNIT V Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

Practical

Study of conidiogenesis- phialides, porospores, arthrospores. Study of fruit bodies in Ascomycotina. Identification of fungi up to species level. Study of hyphal anastomosis. Morphology of representative plant pathogenic genera from different groups of fungi.

MPP-602 Advanced Virology 3(2+1)

Theory

UNIT I Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains.

UNIT II Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction.
UNIT III Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty-, bromo, cucummo, ilar and tospoviruses.
UNIT IV Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.
UNIT V Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants.
UNIT VI Techniques and application of tissue culture. Origin, evolution and interrelationship with animal viruses.

Practical
Purification of virus(es), SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for collecting vectors and their maintenance, nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing, annotation of genes.

MPP-603 Advanced Bacteriology 3(2+1)

Theory
UNIT I Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and biology of bacteria.
UNIT II Current trends in taxonomy of phytopathogenic prokarya.
UNIT III Role of enzyme, toxin, expolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumifaciens*).
UNIT IV Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.
UNIT V Molecular variability among phytopathogenic prokarya and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pasthogens-gene silencing, RNAi technology.
UNIT VI Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit.
UNIT VII Beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Practical
Pathogenic studies and race identification; plasmid profiling of bacteria; fatty acid profiling of bacteria; RAPD prolfiling of bacteria and variability status; Endospore, Flagella staining; test for secondary metabolite production, cyanides, EPS, siderophore; specific detection of phytopathogenic bacteria using species/pathovar specific primers. Basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts.

MPP-604 Molecular Basis of Host-Pathogen Interaction 3(2+1)

Theory

UNIT I Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship.

UNIT II Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

UNIT III Induction of defense responses- pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing.

UNIT IV Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

UNIT V Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical
Protein, DNA and RNA isolation, Plasmid extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

MPP-605 Principles And Procedures of Certification 1(1+0)

Theory
UNIT I Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD, etc. in certification and quality control.
UNIT II Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health, etc.
UNIT III Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative propagules and *in vitro* cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

MPP-606 Plant Biosecurity And Biosafety 2(2+0)

Theory
UNIT I History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.
UNIT II National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.
UNIT III Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

DEPARTMENT OF PLANT PHYSIOLOGY

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)
B.Sc. (Ag.) Courses		
PPH-111	Crop Physiology	3(2+1)
PPH-221	Environmental Science	2(1+1)
PPH-321	Applied Plant Physiology	1(1+1)

M.Sc. (Ag.) Courses

Core Courses

PPH 501	Principles of Plant Physiology	4(3+1)
PPH 502	Plant Developmental Biology-Physiological and Molecular Basis	2(2+0)
PPH 503	Physiological and Molecular Responses of plants to Abiotic Stresses	3(2+1)
PPH 504	Hormonal Regulation of Plant Growth and Development	3(2+1)
PPH 506	Physiology of Growth and Yield and Modeling	2(1+1)
PPH 508	Morphogenesis, Tissue Culture and Transformation	3(2+1)

Optional Courses

PPH 507	Genome Organization In Higher Plants	3(2+1)
PPH 509	Physiology of Crop Plants –Specific Case Studies	2(2+0)
PPH 510	Physiological And Molecular Aspects of Photosynthesis – Carbon and Nitrogen Assimilation	3(2+1)
PPH 511	Mineral Nutrition	3(2+1)
PPH 550	MASTER'S SEMINAR	1(1+0)
PPH 560	MASTER'S RESEARCH	20

Ph.D. Courses

Core Courses

PPH 601	Functional genomics and genes associated with a few physiological processes	2(2+0)
PPH 602	Signal Perceptions And Transduction And Regulation Of Physiological Processes	2(2+0)
PPH 603	Molecular approaches for improving physiological traits	3(2+1)

Optional Courses

PPH 604	Techniques In Plant Physiology	3(1+2)
PPH 605	Climate Change And Crop Growth	2(2+0)
PPH 606	Post Harvest Physiology	3(2+1)
PPH 607	Weed Physiology And Herbicide Action	2(1+1)
PPH 608	Seed Physiology	3(2+1)

Doctoral Seminar and Research

PPH 650	DOCTORAL SEMINAR	1(1+0)
PPH 660	DOCTORAL RESEARCH	45
PPH 651	Reasearch Plan Proposal Seminar	
PPH 652	Pre-Submision Ph.D. Thesis Seminar	

B.Sc. (Ag.) Courses

PPH-111 Crop Physiology 3 (2+ 1)

Introduction, Importance in Agriculture. Seed Physiology, Seed structures, Morphological, physiological and biochemical changes during seed development, Physiological maturity Morphological and physiological changes associated with physiological maturity in crop, Harvestable maturity, Seed viability and vigour, Factors affecting seed viability and vigour. Methods of testing seed viability and vigour, Germination, Utilization of seed reserves during seed germination, Morphological, physiological and biochemical changes during seed germination, Factors affecting seed germination. Growth and Development, Definition, Determinate and Indeterminate growth, Monocarpic and Polycarpic species with examples. Measurement of growth, Growth analysis, Growth characteristics, Definitions and mathematical formulae.

Crop Water Relations, Physiological importance of water to plants, Water potential and its components, measurement of water status in plants. Transpiration, significance, Transpiration in relation to crop productivity, Water Use Efficiency, WUE in C_3, C_4 and CAM plants, Factors affecting WUE, Photosynthesis, Energy synthesis, Significance of C_3, C_4 and CAM pathway, Relationship of Photosynthesis and crop productivity, Translocation of assimilates, Phloem loading, apoplastic and symplastic transport of assimilates, Source and sink concept, Photorespiration, Factors affecting Photosynthesis and productivity, Methods of measuring photosynthesis, Photosynthetic efficiency, Dry matter partitioning, Harvest index of crops. Respiration and its significance, Brief account of Growth respiration and maintenance respiration, Alternate respiration - Salt respiration - wound respiration - measurement of respiration. Nutriophysiology - Definition - Mengel's classification of plant nutrients - Physiology of nutrient uptake - Functions of plant nutrients - Deficiency and toxicity-symptoms of plant nutrients - Foliar nutrition Hydroponics. Introduction of Photoperiodism and Vernalisation in relation to crop productivity – Photoperiodism. Plant Growth Regulators - Occurrence - Biosynthesis - Mode of action of Auxins, Gibberellins, Cytokinins, ABA, Ethylene. Novel plant growth regulators, Commercial application of plant growth regulators in agriculture. Senescence and abscission - Definition - Classification - Theories of mechanism and control of senescence - Physiological and biochemical changes and their significance. Post Harvest Physiology - Seed dormancy - Definition - types of seed dormancy - Advantages and disadvantages of seed dormancy - Causes and remedial measures for breaking seed dormancy, Optimum conditions of seed storage - Factors influencing seed storage (ISTA standards). Fruit ripening - Metamorphic changes - Climateric and non-climateric fruits - Hormonal regulation of fruit ripening (with ethrel, CCC, Polaris, paclobuterozole).

Practical

Preparation of solutions; Growth analysis: Calculation of growth parameters; Methods of measuring water status in roots, stems and leaves; Measurement of water potential by Chardakov's method; Measurement of absorption spectrum of chloroplastic pigments and fluorescence; Measurement of leaf area by various methods; Stomatal frequency and index – Respirometer-Measurement of respirometer; leaf anatomy of C_3 and C_4 plants; Measurement of Transpiration; Imbibition of seed; Optimum conditions for seed germination; Breaking seed dormancy; (a) Chemical method (b) Mechanical method; Yield analysis; Seed viability and vigour tests; Effect of ethylene on regulation of stomata.

PPH-221 Environmental Science 2(1+1)

Scope and importance of environmental studies. Natural resources: Renewable and Non-renewable resources. Forest, Water, Food, energy and land resources. Ecosystems: Definition, concept, structure and functions. Producers, consumers and decomposers of an ecosystem. Energy flow in the ecosystem. Types of ecosystems. Bio-diversity: Definition, classification, threats to biodiversity and its conservation. Environmental pollution: Causes, effects and control of air, water, soil, thermal, noise and, marine pollution. Causes, effects and management of soil nuclear hazards and industrial wastes. Disaster management, Floods, earthquakes, cyclones and land slides. Social issues and the environment, unsustainable to sustainable development. The Environment Protection Act, The Air Act, The water Act, The Wildlife Protection Act and Forest Conservation Act. Woman and child welfare, HIV / AIDS and Role of information technology on environment and human health.

Practical

Collection, processing and storage of effluent samples; Determination of Biochemical oxygen demand (BOD) in effluent sample; Determination of chemical oxygen demand (COD) in effluent sample; Estimation of dissolved oxygen in effluent samples; Determination of sound level by using sound level meter; Estimation of respirable and non respirable dust in the air by using portable dust sampler; Determination of total dissolved solids (TDS) in effluent samples; Estimation of species abundance of plants; Estimation of nitrate contamination in ground water; Analysis of temporary and total hardness of water sample by titration; Estimation of pesticide contamination in Agro-Ecosystem; Visit to Social Service Organization / Environmental Education Centre; Crop adaptation to environmental variables, soils conditions; Study of

transpiration and water balance in plants; Visit to a local polluted site. Observations and remedial measures; Assessment of chlorophyll content of fresh water / sea water ecosystem.

PPH-321 Applied Plant Physiology 3 (2+1)

Physiological basis of yield: External and internal factors controlling photosynthetic productivity and photo respiratory losses, Partitioning of photosynthate and its regulation by mineral nutrients and phytohormones with reference to economic yield, Physiological maturity and harvest index, Flower shedding and pod drop in legumes, Boll shedding in cotton. **Signal transduction:** Sugar and nitrate signaling, ABA signal transduction, Role of calcium and calmodulin in signal transduction. **Practical aspects of hydroponics:** Advantages and disadvantages, foliar nutrition. Applications of **plant tissue culture** in agriculture, horticulture and forestry. Practical applications of **seed priming** in agriculture. Economics of **biological N_2 fixation**, Nitrogen assimilation. **Allelopathic** effects of crops. **Post harvest physiology:** Physiological principles of storage of seeds and fruits, biochemical changes during post harvest storage of fruits, physiology of seed and fruit maturation, molecular basis of senescence and fruit ripening.

Practical: Leaf area determination by conventional methods, Harvest index, Preparation of balanced nutrient solution, Sand washing, Set up of soil-less culture to diagnose deficiency of mineral elements, Seed viability test, Seed priming, Aseptic techniques and preparation of nutrient media for plant tissue culture, Study of biochemical changes during senescence of plant parts : Estimation of sugars and proteins.

M.Sc. (Ag.) Courses

PPH 501 Principles of Plant Physiology 4(3+1)

Theory

UNIT I

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions.

UNIT II

Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells.

UNIT III

Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorhizal association on water uptake.

UNIT IV

Water loss from plants-Energy balance-Solar energy input-energy dissipation at crop canopy level- evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate.

UNIT V

Stomata structure and function – mechanism of stomatal movement, antitranspirants.

UNIT VI

Physiology of water stress in plants: Influence of water stress at cell, organ, plant and canopy levels. Indices for assessment of drought resistance.

UNIT VII

The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants.

UNIT VIII

Uptake of mineral elements in plants –Mechanisms of uptake-translocation of minerals in plants.

UNIT IX

Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar nutrition.

UNIT X

Photosynthesis and its importance in bio productivity. Photochemical process, photochemical reactions, CO_2 reduction in Calvin cycle, supplementary pathway of C fixation in C4 and CAM plants and its significance.

UNIT XI

Photorespiration and its relevance. Photosynthesis as a diffusive processeffect of environmental factors on photosynthetic rates. Synthesis of sucrose, starch, oligo and polysaccharides (composition of cell wall). Translocation of photosynthates and its importance in sink growth.

UNIT XII

Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance.

UNIT XIII

Nitrogen metabolism: Inorganic nitrogen species (N_2, NO_3 and NH_3) and their reduction to aminoacids, protein synthesis and nucleic acids.

Unit XIV

Lipid metabolism- Storage, protective and structural lipids. Biosynthesis of fattyacids, diacyl and triacyl glycerol, fatty acids of storage lipids. Secondary metabolites and their significance in plant defence mechanism.

UNIT XV

Growth and differentiation. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators, growth retardants., Apical dominanace, senescence, fruit growth, abscission.

UNIT XVI

Photo morphogenesis: Photo receptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalisation.

Practical

Measurement of soil water status: Theory and principle of pressure plate apparatus, neutron probe, Measurement of plant water status: Relative water content, water saturation deficits Chardakov's test. Theory and principle of pressure bomb, psychrometer and osmometer, Measurement of transpiration rate. Measurement of vapour pressure deficits, theory and principle of porometry, diffusion prometer and Steady state porometer, Stomatal physiology, influence of ABA on stomatal closing. Mineral nutrients: Demonstration of energy requirement for ion uptake. Deficiency symptoms of nutrients, Radiant energy measurements, separation and quantification of chlorophylls, O2 evolution during photosynthesis, Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration, Respiration rates, Estimation of reducing sugars, starch. Estimation of NO3, free aminoacids in the xylem exudates, quantification of soluble proteins. Bioassays for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and ethylene.

Demonstration of photoperiodic response of plants in terms of flowering.

PPH 502 Plant Developmental Biology Physiological And Molecular Basis 2(2+0)
Theory
UNIT I

Plant Biodiversity, Concept of evolution in plants.

UNIT II

General Aspects – Novel features of plant growth and development; Concept of plasticity in plant development; Analysing plant growth.

UNIT III

Seed Germination and Seedling Growth – Mobilization of food reserves during seed germination; tropisms; hormonal control of seed germination and seedling growth.

UNIT IV

Shoot, Leaf and Root Development – Organization of shoot apical meristem (SAM); Control of cell division and cell to cell communication; Molecular analysis of SAM; Leaf development and differentiation; Organization of root apical meristem (RAM); Root hair and trichome development; Cell fate and lineages.

UNIT V

Floral Induction and Development – Photoperiodism and its significance; Vernalization and hormonal control; Inflorescence and floral determination; Molecular genetics of floral development and floral organ differentiation; Sex determination.

UNIT VI

Seed Development and Dormancy – Embryo and endosperm development; Cell lineages during late embryo development; Molecular and genetic determinants; Seed maturation and dormancy.

UNIT VII

Senescence and Programmed Cell Death (PCD) – Senescence and its regulation; Hormonal and environmental control of senescence; PCD in the life cycle of plants.

UNIT VIII

Light Control of Plant Development – Discovery of phytochromes and cryptochromes, their structure, biochemical properties and cellular distribution; Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks and their genetic and molecular determinants

UNIT IX

Embryonic Pattern Formation – Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants.

UNIT X

Regeneration and totipotency; Organ differentiation and development; Cell lineages and developmental control genes in maize.

UNIT XI

Special Aspects of Plant Development and Differentiation – Pollen germination and pollen tube guidance; Phloem differentiation; Sex determination in plants;

UNIT XII

Self-incompatibility and its genetic control; Heterosis and apomixis.

PPH 503 Physiological And Molecular Responses of Plants To Abiotic Stresses 3(2+1)

Objective

To apprise the students regarding abiotic stress to plant and its molecular basis.

Theory

UNIT I

Response of plants to abiotic stresses: Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress, Interactions between biotic and abiotic stresses.

UNIT II

Drought-characteristic features, Water potential in the soil-Plant air continuum. Development of water deficits, energy balance concept.

UNIT III

Transpiration and its regulation – stomatal functions.

UNIT IV

Physiological processes affected by drought. Drought resistance mechanisms: Escape Dehydration postponement (Drought avoidance), Dehydration tolerance and characteristics of resurrection plants. Osmotic adjustment, Osmoprotectants, Stress proteins. Water use efficiency as a drought resistant trait.

UNIT V

Molecular responses to water deficit: Stress perception, Expression of regulatory and functional genes and significance of gene products.

UNIT VI

Stress and hormones- ABA as a signaling molecule- Cytokinin as a negative signal. Oxidative stress: Reactive Oxygen Species (ROS). Role of scavenging systems (SOD catalase etc.).

UNIT VII

High temperature stress: Tolerance mechanisms- role of membrane lipids in high temperature tolerance. Functions of HSP's.

UNIT VIII

Chilling stress: Effects on physiological processes. Crucial role of membrane lipids.

UNIT IX

Salinity: Species variation in salt tolerance. Salinity effects at – Cellular and whole plant level, tolerance mechanisms. Salt tolerance in – Glycophytes and halophytes, Breeding for salt resistance.

UNIT X

Heavy metal stress: Aluminium and cadmium toxicity in acid soils. Role of Phytochelatins (heavy metal binding proteins).

Practical

Measurement of water status of plants, determination of osmotic potential by vapour pressure and freezing point depression, Determination of soil water potential and content by psychrometry and other systems. Stress imposition and quantification, Stress –stomatal conductance. Canopy temperature as a reflection of transpiration and root activity,Water use – efficiency, Determination at whole plant and single leaf level,Root- shoot signals-ABA and cytokinin effect on stomatal behavior, Heat tolerance and membrane integrity. Sullivans heat tolerance test, chilling tolerance- Galactolipase and free fatty acid levels as biochemical markers for chilling damage, Cold induced inactivation of O2 evolution of chloroplasts- as a screening technique for chilling tolerance.

PPH 504 Hormonal Regulation of Plant Growth And Development 3(2+1)

Theory

UNIT I

Definition and classifiacation of palnt growth regulators- Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones. tricontanol, Phenols –polyamines, jasmonates, Concept of death hormone.

UNIT II

Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberlins, cytokinins, Abscisic acid and Ethylene Brassinosteroids.

UNIT III

Hormone mutants and transgenic plants in understanding role of hormones.

UNIT IV

Signal perception.transduction, and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening.

UNIT V

Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings-Flowering. Apical dominance, molecular aspects of control of reproductive growth and development.

UNIT VI

Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Practical

Quantification of Hormones- Principles of bioassays, physico chemical techniques and immunoassay, Extraction of hormones from plant tissue.Auxins- bioassays- auxins effect onrooting of cuttings, abscission, apical dominance, Gibberellins- bioassays-GA effect on germination of dormant seeds, cytokinin- bioassays- estimation using immunoassay technique cytokinin effect on apical dormance and senescence, ABA bioassaysestimation using immunoassay technique. ABA effect on somatal movement, Ethylene bioassays, estimation using physico chemical techniques- effect on breaking dormancy in sunflower and groundnut.

PPH 506 Physiology of Growth And Yield And Modeling 2(1+1)

Theory

UNIT I

Crop growth analysis, key growth parameters. Analysis of factors limiting crop growth and productivity- the concept of rate limitation

UNIT II

Phenology- Growth stages, internal and external factors influencing flowering. Photoperiodic and thermo-periodic responses and the concept of Degree days and crop growth duration.

UNIT III

Canopy architecture, light interception, energy use efficiency of different canopies. LAI, LAD. concept of optimum LAI.

UNIT IV

Source-sink relationships. Translocation of photosynthates and factors influencing transport of sucrose. Physiological and molecular control of sink activity – partitioning efficiency and harvest index.

UNIT V

Plant growth analysis techniques, yield structure analysis, theoretical and actual yields.

UNIT VI

Plant ideotypes,

UNIT VII

Simple physiological yield models- Duncan's. Monteith's, and Passioura's

UNIT VIII

Crop growth models-empirical models testing and yield prediction.

Practical

Plant sampling for leaf area and biomass estimation; analysis of growth and yield parameters – LAD, NAR. CGR, LAI, LAR, SLA portioning efficiency HI, Measurement of light interception, light extinction coefficient, energy utilization efficiency based energy intercepted, and realized, Computer applications in plant physiology, crop productivity and modeling.

PPH 507 Genome Organization In Higher Plants 3(2+1)

Theory

UNIT I

Introduction: Basic discoveries in molecular genetics; basic concepts on genome organization and its replication in prokaryotic systems including cyanobacteria; genome organization in diploids, tetraploids, autoptetraploids and polyploids.

UNIT II

Gene & gene expression: Diversity in DNA polymerases; control of plasmid copy number; Regulation of transcription in prokayotes; Promoters and terminators; Positive and negative control of transcription; Repression and activation-operon concept.

UNIT III

Mitochondrial and chloroplastic genome organization and regulation of gene expression.

UNIT IV

Eukaryotic genome structure: Organization and replication; control of gene expression-transcription and post-transcriptional; promoter analysis; concept of cis elements; transcription factors, function and role of RNA polymerases.

UNIT V

Genetic code and translation-deciphering the genetic code; Codon bias; tRNAs, ribosomes; Initiation and termination of translation; Translational and post-translational controls; Attenuation ; Suppressor tRNAs.

UNIT IV

Mobile genetic elements; Structure and function of transposable elements; Mechanism of transposition; Special features of retroptransposans; Repair and recombination.

Practical

Culturing and transformation of bacteria; genomic DNA and plasmid DNA isolation from bacteria, restriction enzyme digestion and analysis by agarose gel electrophoresis, isolation of genomic DNA and RNA from plants and quantification; Culture of bactriophage; studis on lytic and lysogenic phages.

PPH 508 Morphogenesis, Tissue Culture And Transformation 3(2+1)

Theory

UNIT I

Morphogenesis: The cellular basis of growth and morphogenesis cytodifferentiation.

UNIT II

The cell cycle-cell division and cell organization, cell structure, tissue and organ differentiation. Control of cell division and differentiation in selected cell types, Introductory history, morphogenesis and cellular totipotency.

UNIT III

Introduction to in vitro methods : Terms and definitions, Use of growth regulators, Beginning of in vitro cultures in our country (ovary and ovule culture , in vitro pollination and fertilization), Embryo culture, embryo rescue after wide hybridization and its application, Endosperm culture and production of triploids.

UNIT IV

Introduction to the processes of embryogenesis and organogenesis and their practical applications : Clonal Multiplication of elite species (micropropagation) – axillary bud, shoot – tip and meristem culture. Haploids and their applications. Somaclonal variations and applications (treasure your exceptions).

UNIT V

Introduction to protoplast isolation : Principles and applications . Testing of viability of isolated protoplast . Various steps in the regeneration of protoplast . Somatic hybridization – an introduction, Various methods for fusing protoplast, chemical and electrical . Use of makers for selection of hybrid cells. Practical applications of somatic hybridization (hybrids vs cybrids)

UNIT VI

Use of plant cells, protoplast and tissue culture for genetic manipulation of plant : Introdiuction to *A. tumefaciens*. Tumour formation on plants using *A. tumefaciens* (Monocots vs Dicots), Root – formation using *A.rhizogenes*

Practical

In vitro culture of different explants such as leaf, stem, shoot apex, cotyledonary nodes; Effect of explant age on propagation potential, Effect of growth regulators auxin, cytokinins and ethlyne on callus induction, organogenesis; Somatic embryogenesis, Effect of growth conditions such as temperature and photoperiod on organogenesis, Single – cell suspension cultures.

PPH 509 Physiology of Crop Plants – Specific Case Studies 2(2+0)

Theory

UNIT I

Crop physiological aspects of rice, wheat, maize, sorghum, millets, sugarcane, pulses, oil seeds, cotton and potato Crops. Six to Eight Species could be chosen based on local importance.

UNIT II

Crop specific topics.

UNIT III

Seed dormancy, photoperiodic and thermoperiodic responses.

UNIT IV

Source-sink relationship, Yield structure and factors influencing yield, Nutrients and other resource requirements and crop specific features.

PP 510 Physiological And Molecular Aspects Of Photosynthesis-Carbon And Nitrogen Assimilation 3(2+1)
Theory

UNIT I

Photosynthesis- its significance in plant growth, development and bio productivity. Gaseous fluxes in atmosphere.

UNIT II

Physiological and biochemical aspects: chloroplast structure development and replication, ultra structure of thylakoids, photo systems, mechanism of light absorption, chloroplast electron transport chain, Coupling factors and mechanisms of ATP synthesis, and concept of quantum yield.

UNIT III

Photosynthetic carbon reduction cycle and its regulation. CO2 Concentration Mechanism (CCM) as a complementary strategy for carbon fixation. CCM in photosynthetic bacteria, micro algae, Submerged Aquatic macrophages (SAM), C4, CAM and single celled C4 organisms, C3-C4 intermediates. Ecological significance of CCM.

UNIT IV

Rubisco structure, assembly and kinetics, photorespiration and its

significance.

UNIT V

Carbon fluxes between chloroplast and cytoplasm and Carbon fixation as a diffusive process, the concept of ra, rs and rm. Pi recycling, starch and sucrose synthesis and export. Concept of canopy photosynthesis, influence of environmental factors such as water stress, high light stress VPD etc.

UNIT VI

Molecular aspects: chloroplast genome organization, expression and regulation of plastid genes Genes regulating potential traits of photosynthesis, biotechnological approaches for improving photosynthetic rate and productivity – transgenics. Conceptual approaches of expressing C4 photosynthesis genes in C3 species.

UNIT VII

Photosynthesis and crop productivity, energy utilization efficiency by crops. Photo inhibition, photo oxidation, excitation energy dissipation mechanisms, photochemical and no-photochemical quenching of chlorophyll fluorescence. Photosynthesis and transpiration interaction, significance of WUE, carbon isotope discrimination concept.

UNIT VIII

Prospects of improving photo synthetic rate and productivity – potential traits of photosynthesis- biotechnological approaches.

UNIT IX

Nitrogen assimilation in photosynthesizing cells – NO3-, NO2- reduction, GS-GOGAT pathway. Photorespiration loss of Ammonia and its reassimilation and NUE.

Practical

Extraction and separation of plant pigments, Isolation of chloroplasts ETC reactions- O2 evolution, Determination of rubisco content (western and ELISA), activity and activation state, Enzymatic determination of starch and sucrose, Determination of photosynthetic rates –gas exchange. A, gs, Ci, A/gs, C/gs- intrinsic WUE by gas exchange rates. Light, CO2, VPD

response curves, Determination of photorespiration by gas exchange- (TPSAPS). Genotypic/species differences in photosynthetic rates. Measurement of radiation, Eu% light interception, Determination of NH4+, reduction of

inorganic nitrogen species.

PPH 511 Mineral Nutrition 3(2+1)

Theory

UNIT I

Overview of essential mineral elements, kinetics of nutrient uptake by plants. Biological actions influencing nutrient availability near the root system.

UNIT II

Nutrient uptake by root cells, long distance transport in plants and movement into developing grains. Nutrient transport from vegetative to reproductive organs during reproductive stage of growth and maturity.

UNIT III

Molecular mechanism of ion uptake, ion transporters, specific examples of transporters for Nitrate, Phosphate, Potassium and other nutrients. Multiple transporters for a single ion and their functional regulation.

UNIT IV

Molecular physiology of micronutrient acquisition. Examples of genes encoding mineral ion transporters. Strategies plants adopt to acquire and transport minerals under deficient levels.

UNIT V

Physiological and molecular mechanisms underlying differential nutrient efficiency in crop genotypes, Examples of Phosphorous, Iron and Zinc efficient crop varieties.

UNIT VI

Breeding crop varieties for improved nutrient efficiency. Plant responses to mineral toxicity.

Practical

Physiological and biochemical changes in plants under nutrient sufficiency and deficiency levels. Quantification of pigment levels, enzyme activities.

Ph.D. Courses

PPH 601 Functional Genomics And Genes Associated With A Few Physiological Processes 2(2+0)

Theory

UNIT I

Gene discovery: Finding Genes in Complex Plant System, Constructing Gene-Enriched Plant Genomic Libraries, In Silico Prediction of plant Gene Function, Quantitative Trait Locus Analysis as a Gene Discovery Tool.

UNIT II

Genetic tools for plant development- Understanding the importance of mutants in unraveling the physiological processes – T-DNA insertion mutants, Gain in function, Transposon mutagens, Transposition, Physical and Chemical mutagenesis, Gene and Enhancer Traps for Gene Discovery, High-Throughput TAIL-PCR as a Tool to identify DNA Flanking insertions, High-Throughput TILLING for functional Genomics.

UNIT III

Gene knock out approaches: Antisense technology, Virus induced gene silencing (VIGS), Custom Knock-outs with Haripin RNA-mediated Gene Silencing and other silencing tools, Complementation studies, DNA micro arrays.

UNIT IV

Gene Over expression approaches: Vector Construction for Gene Overexpression as a Tool to Elucidate Gene Function; Transient expression, Transgenics.

UNIT VI

Proteomics: Networking of Biotechnology for interpreting gene functions. Yeast two hybrid systems to study protein – protein interaction to study gene functions, Proteomics as a Functional Genomics Tool, Crystallographic and NMR approaches to determine protein structures.

UNIT VII

Functional characterization of genes associated with important cellular processes influencing crop growth and development.

UNIT VIII

Case studies of genes controlling photosynthesis, respiration, photorespiration, fatty acid biosynthesis, nutrient uptake, flowering, seed protein quality and quantity.

PPH 602 Signal Perceptions And Transduction And Regulation of Physiological Processes 2(2+0)

Theory

UNIT I

General aspects: Introduction to signaling-Long range (Diffusible) signaling and short range (contact) signaling. Components of signaling- Upstream components: receptor and ligands concept-types of ligands and its relevance-receptor

kinases-Two component sensing system. Down stream components: G. proteins-second messengers-Cyclic AMP, adenylate cyclase cascade, cyclic GMP, calcium-calmodulin-Kinases-Effector molecules (transcription factor).

UNIT II

Hormone signaling: Hormone binding receptors-Transduction process. Effector molecules and gene expression.

UNIT III

Specific signaling pathways of Auxins, Cytokinisn, Gibberllins, Ethylene, ABA, Brassinosteroids which leads to formative effects. The cross talk in the signaling of different hormones-significance of studies with hormone action mutants.

UNIT IV

Light signaling: Perception of light-pigments involved-activation of phytochrome/cryptochrome (study of mutants). Light signal transduction- Multiple signaling cascades-identification of signaling components through mutant analysis-changes in gene expression.

UNIT V

Abiotic stress signaling: Sensing of environmental factors (Temperature- Osmoticum-Ionic stress) Activation of specific molecules and secondary messengers-Activation of Down stream components-leading to stress gene expression. Case studies with different abiotic stresses.

UNIT VI

Cross talk between signaling pathways.

UNIT VII

Signal perception and transduction in plant defense responses: Role of salicylic acid and active oxygen species.

UNIT VIII

Signaling cascade during leaf senescence, abscission, flowering and tuberisation

UNIT IX

Carbon and Nitrogen as signaling agents in Plant Metabolism.

PPH 603 Molecular Approaches For Improving Physiological Traits 3(2+1)

Theory

UNIT I

Importance of Molecular Breeding for complex multi-gene controlled physiological traits and its relevance in augmenting trait based breeding. Physiological traits with relevance to growth, development, abiotic stress tolerance, nutrient acquisition, Approaches for accurate phenotyping of large germplasm accessions and/or mapping populations.

UNIT II

The advantages of “Trait based” breeding approaches. Concept of segregation, independent assortment and linkage. The concept of molecular markers, various types of Dominant and Co-dominant marker systems.

UNIT III

Relevance and development of mapping populations and genetic analysis using marker systems. Advantages of association mapping and the concept of linkage, LD decay and population structure.

UNIT IV

Statistical analysis to assess the variance in phenotypic traits and molecular data. Assessment of genetic parameters such as heritability, genetic advance etc.

UNIT V

Strategies for QTL introgression and Marker Assisted Selection (MAS). Map based cloning of novel genes and alleles. Allele mining

UNIT VI

Transgenic approach in improving physiological processes- Introduction to GMOs and application in crop improvement; gene mining, sequence structure & function analysis using bioinformatics tools, identification of candidate genes for various physiological process associated with specific traits (such as stress tolerance) and their potential benefits in transgeniccrops.

UNIT VII

Cloning full-length candidate genes, stress inducible promoters, strategies to clone and characterize and make constructs for specific crops, gene stacking strategies, tissue specific expression and functional validation of genes.

UNIT VIII

Transformation of crop plants-*Agrobacterium* and use of other organisms for transformation-particle gun transformation and other methods.

UNIT IX

Selection of transformants- molecular analysis on the basis of qRT-PCR, Southern, Northern analysis and immunoassays; estimation of copy number. Concept of desirable number of independent events.

UNIT X

Evaluation of transgenics on basis of empirical/physiological/biochemical process under specific conditions on the basis of gene function. Generation of T1 populations, event characterization and generation of molecular data as per the regulatory requirements.

UNIT XI

Issues related to Biosafety and Registration of Transgenic Agricultural Organisms, methods to detect GMOs from agricultural products.

Practical

Phenotyping approaches for the different physiological traits. Genotyping options using gene-scan systems. Development of SSR, SNP and SCAR markers, resolution of polymorphism on agarose gels and PAGE, genotyping using a DNA sequencing machine, scoring of gels and assessment of polymorphism, Statistical approaches to assess genetic variability, heritability and other parameters, Phylogenic analysis, Principal component analysis and construction of dendrograms. Construction of Linkage map, QTL maps, population structure, LD decay etc leading to identification of QTLs, Bioinformatics – sequence analysis, structure analysis, Molecular biology - genomic/plasmid DNA isolation, RNA isolation. Full-length gene cloning, vector construction with specific promoter, gene stacking & transient assays. Transformation in model system,Crop transformation - *Agrobacterium* mediated transformation (inplanta & invitro), particle-gun transformation, Evaluation of transgenics – semiquantitative & quantitative RT-PCR, southern blot, northern blot, western blot and ELISA, biochemical/physiological assay based on the function of gene & testing LOD.

PPH 604 Techniques In Plant Physiology 3(1+2)

Theory

UNIT I

Recent experimental techniques to study various physiological processes, Photosynthetic gas exchange measurements, light and CO2 response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements.

UNIT II

Estimation of water use efficiency at whole plant and single leaf level. Use of stable isotopes to understand physiological processes.

UNIT III

Radio isotopes in plant biology.

UNIT IV

Tools and techniques (molecular and biochemical) to study physiological processes and to screen & assess stress responses in plants, such as (a) DNA & RNA isolation, cDNA synthesis & library construction, semiquantitative & quantitative RT-PCR, northern blot, immunoassays; (b) techniques for defined physiological processes.

UNIT V

Methods to phenotype germplasm for specific physiological traits.

UNIT VI

Quantification of mineral nutrients using advanced instruments like AAS, & ICP.

UNIT VII

Techniques in plant transformation & analysis of transgenic plants

UNIT VIII

Molecular markers- genetic distance and mapping population concept of linkage maps and identification of QTLS.

UNIT IX

Instrumentation: Acquaintance of the operation of specific instruments important in physiological research like Mass spec., phosphor-imager, DNA sequencer, spectro-fluorometer, oxygen electrode, etc.

Practical

Photosynthetic gas exchange measurements, light and CO2 response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements. Estimation of water use efficiency at whole plant and single leaf level. Use of stable and radioactive isotopes to understand physiological processes. DNA & RNA isolation, cDNA synthesis & library construction, semiquantitative & quantitative RT-PCR, northern blot, immunoassays; techniques for defined physiological processes, Quantification of mineral nutrients using advanced instruments like AAS.

PPH 605 Climate Change And Crop Growth 2(2+0)

Theory

UNIT I

History and evidences of climate change and its implications. Effect of climate change on monsoons, hydrological cycle and water availability.

UNIT II

Natural and anthropogenic activities and agricultural practices on GHG production, Monitoring of greenhouse gases and their influence on global warming and climate change, Ozone depletion leading to increased ionizing radiations and its implications on crop growth.

UNIT III

Long-term and short-term projections of climate change effects on natural vegetations and ecosystems, crop-pest interaction, area shift, food production and supply.

UNIT IV

Approaches to mitigate climate change through studies on plant responses.

UNIT V

Direct and indirect effects of climate change on plant processes – phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield.

UNIT VI

Conventional and biotechnological approaches to improve the crop adaptation to climate change. Relevance of “Genome wide mutants” to identify genes/processes for improved adaptation to changing environments

UNIT VII

International conventions and global initiatives on Carbon sequestration, carbon trading.

PPH 606 Post Harvest Physiology 3(2+1)

Theory

UNIT I

Environmental factors influencing senescence, ripening and post harvest life of flowers, vegetables and seeds.

UNIT II

Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening.

UNIT III

Senescence associated genes and gene products.

UNIT IV

Functional and ultrastructural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening.

UNIT V

Regulatory role of ethylene in senescence and ripening, ethylene biosynthesis, perception and molecular mechanism of action.

UNIT VI

Post harvest changes in seed and tubers biochemical constituent's quality parameters. Effect of environmental factors on post harvest changes in seed

and tubers.

UNIT VII

Biotechnological approaches to manipulate ethylene biosynthesis and

action.

UNIT VIII

Alternate post harvest methodology and quality attributes. Scope for genetic modification of post harvest life of flowers and fruits.

UNIT IX

Uses of GM crops and ecological risk assessment.

Practical

Physiological and biochemical changes during senescence and ripening, Estimation of ethylene during senescence and ripening, determination of Reactive Oxygen Species and scavenging enzymes, Measurement of dark and alternate respiration rates during senescence and ripening. Estimation of ripening related enzyme activity, Cellulases pectin methyl esterases, polygalacturonase etc.

PPH 607 Weed Physiology And Herbicide Action 2(1+1)

Theory

UNIT I

Weed biology, ecology and physiology. Weed and crop competition, allelochemicals, their nature and impact. Weed-seed physiology.

UNIT II

Classification of herbicides and selectivity. Recent concepts on entry, uptake, translocation and metabolism of soil and foliar applied herbicides.Environmental and plant factors influencing entry, uptake and translocation of herbicides.

UNIT III

Classification and chemistry of common herbicides. Physiological, biochemical and molecular mechanism of action of different groups of herbicides; ACC synthase inhibitors, ALS inhibitors, Mitotic inhibitors, Cellulose biosynthesis inhibitors, Inhibitors of fatty acid biosynthesis, inhibitors of Photosynthesis, Auxinic Herbicides, New herbicides,

UNIT IV

Metabolic pathway of herbicide degradation in plants and soil. Herbicide adjuvants and their classification.

UNIT V

Molecular mechanism of action of herbicide synergists and antagonists.

UNIT VI

Physiological and molecular mechanism of herbicide selectivity.

UNIT VII

Herbicide resistant crops; transgenic & tissue culture approaches to develop herbicide tolerant varieties

Practical

Adjuvants and their effect on spray droplets, chemical entry and transport. Determination of physiological and biochemical processes like photosynthesis, respiration, cell division, Protein & fatty acid synthesis, membrane permeability as affected by herbicides. Quantification of pigment levels in leaves, specific enzyme activities affected by herbicides. Demonstration of translocating type of herbicides by radio labeling studies.

PPH 608 Seed Physiology 3(2+1)

Theory

UNIT I

Seed and fruit development, seed and fruit abortion, proximate mechanism of seed and fruit abortion. Hereditary and environmental effect on seed development. Gene imprints and seed development.

UNIT II

Importance of seeds, seed structure and function, physiological and biochemical changes, environmental influences, physiology of seed and fruit development; seed and fruit abortion and means to overcome it; proximate mechanisms of seed and fruit abortion.

UNIT III

Structure of seeds and their storage resources, seed developmental patterns and source of assimilates for seed development.

UNIT IV

Pathway of movement of assimilates in developing grains of monocots and dicots, Chemical composition of seeds, Storage of carbohydrates, proteins and fats in seeds and their biosynthesis.

UNIT V

Seed respiration, mitochondrial activity, Seed ageing, Mobilization of stored resource in seeds, Chemistry of oxidation of starch, proteins and fats, Utilization of breakdown products by embryonic axis.

UNIT VI

Control processes in mobilization of stored resources, Role of embryonic axes, Gibberllin and a-amylase and other hydrolytic activity. Seed maturation phase and desiccation damage, Role of LEA proteins.

UNIT VII

Seed viability, Physiology of and means to prolong seed viability, Seed vigour: concept, importance, measurement; invigoration: methods and physiological basis of it, Seed dormancy, types and regulation, Means to overcome seed dormancy.

Practical

Determination of seed storage proteins, Sink drawing ability of ovules, empty ovule technique, Alpha-amylase activity in germinating seeds, Role of GA in inducing amylase activity, Role of embryo in GA induced aamylase activity, Protease and lipase activity in germinating seeds, Seed viability test and accelerated ageing test. Seed hardening/osmotic priming of seeds, Seed respiration rates, Seed viability losses through membrane leakage studies.

DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

List of Courses

Course No.	Course Title	Credit Hours (Theory + Practical)
B.Sc. (Ag.) Courses		
SSC-121	Introduction to Soil Science	3 (2+1)
SSC-211	Biochemistry	3(2+1)
SSC-221	Fertilizes and Agro-Chemicals	3(2+1)
SSC-321	Soil Chemistry, Soil Fertility and Nutrient Management	3(2+1)
M.Sc. (Ag.) Courses		
SSC 501	SOIL PHYSICS	3(2+1)
SSC 502	SOIL FERTILITY AND FERTILIZER USE	4(3+1)
SSC 503	SOIL CHEMISTRY	3(2+1)
SSC 504	SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY	3(2+1)
SSC 505	SOIL EROSION AND CONSERVATION	3(2+1)
SSC 506	SOIL BIOLOGY AND BIOCHEMISTRY	3(2+1)
SSC 507	GEOMORPHOLOGY AND GEOCHEMISTRY	2(2+0)
SSC 508	RADIOISOTOPES IN SOIL AND PLANT STUDIES	2(2+0)
SSC 509	SOIL,WATER AND AIR POLLUTION	3(2+1)
SSC 510	REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES	3(2+1)
SSC 511	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	2(2+0)
SSC 512	SYSTEM APPROACHES IN SOIL AND CROP STUDIES	3(2+1)
SSC 513	MANAGEMENT OF PROBLEMATIC SOILS AND WATERS	3(2+1)

SSC 514	FERTILIZER TECHNOLOGY	1(1+0)
SSC 515	LAND DEGRADATION AND RESTORATION	1(1+0)
SSC 591	MASTER'S SEMINAR	1(1+0)
SSC 599	MASTER'S RESEARCH	20

Ph.D. Courses

SSC 601	ADVANCES IN SOIL PHYSICS	3(2+1)
SSC 602	ADVANCES IN SOIL FERTILITY	3(2+1)
SSC 603	PHYSICAL CHEMISTRY OF SOILS	2(2+0)
SSC 604	SOIL GENESIS AND MICROPEDOLOGY	2(2+0)
SSC 605	BIOCHEMISTRY OF SOIL ORGANIC MATTER	3(2+1)
SSC 606	LAND USE PLANNING AND WATERSHED MANAGEMENT	2(2+0)
SSC 607	ADVANCES IN SOIL MICROBIOLOGY	3(2+1)
SSC 608	ADVANCED INSTRUMENTAL TECHNIQUES	3(2+1)
SSC 691	DOCTORAL SEMINAR I	1(1+0)
SSC 692	DOCTORAL SEMINAR II	1(1+0)
SSC	SYNOPSIS SEMINAR	
SSC	PRE-SUBMISSION SEMINAR	
SSC 699	DOCTORAL RESEARCH	45

SSC-121 Introduction to Soil Science 3 (2+1)

Soil: Pedological and edaphological concepts, Origin of the earth, Earth's crust; Composition: Rocks and minerals Weathering, Soil formation factors and processes, Components of soils; Soil profile, Soil physical properties, Soil texture, Textural classes, Particle size analysis, Soil structure Classification, Soil aggregates, significance, Soil consistency, Soil crusting, Bulk density and particle density of soils & porosity, their significance and manipulation, Soil compaction, Soil Colour, Elementary knowledge of soil classification and soils of India; Soil water. Retention and potentials, Soil moisture constants, Movement of soil water, Infiltration, percolation, permeability, Drainage, Methods of determination of soil moisture Thermal properties of soils, Soil temperature, Soil air, Gaseous exchange, Influence of soil temperature and air of plant growth; Soil colloids, Properties, nature, types and significance; Layer silicate clays, their genesis and sources of charges, Adsorption of ions, Ion exchange, CEC & AEC Factors influencing ion exchange and its Significance. Soil organic matter, composition, Decomposability, Humus, Fractionation of organic matter, Carbon cycle, C:N ratio. Soil biology, Biomass, Soil organisms and their beneficial and harmful roles.

Practical: Determination of bulk density and particle density, Aggregate analysis, Soil strength, Soil moisture determination, Soil moisture constants – Field capacity Infiltration rate, water holding capacity, soil texture and mechanical analysis – Soil temperature. Analytical chemistry – Basic concepts, techniques and calculations – Collection and processing of soil for analysis – Organic carbon, pH, EC, soluble cations and anions – Study of a soil profile – Identification of rocks and minerals.

SSC-211 Biochemistry 3(2+1)

Biochemistry – Introduction and importance. Plant cell, cell wall and its role in live stock, food and paper industries. Bio-molecules – Structure, properties & application: Amino acids, peptides and proteins – Plant proteins and their quality. Enzymes – Factors affecting the activity, classification, Immobilistion and other industrial applications. Lipids – Acyl lipids, Their industrial application in soaps, detergents, paints, Varnishes, lubricants, adhesives, plastics, nylon, Bio-diesel, Biodegradable plastics etc. Carbohydrates; Nucleotides and Nucleic acids. Metabolic energy and its generation – Metabolism – Basic concepts, Glycolysis, Citric and Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. General reactions of amino acid degradation. Biosynthesis – carbohydrates, Lipids, Proteins and Nucleic acids. Metabolic regulation. Secondary metabolites, Terpenoids, Alkaloids, Phenolics and their applications in food and pharmaceutical industries.

Practical: Amino acid models (atomic); Paper electrophoresis for the separation of plant pigments; Protein denaturation – heat, pH, precipitation of proteins with heavy metals, Protein estimation by Lowry method; Enzyme kinetics, competitive inhibition, enzyme immobilization; Extraction of nucleic acids, column chromatography of RNA hydrolysate; Characterization of lipids by T.L.C.; Extraction of oil from oil seeds; Estimation of fatty acids by G.L.C.; Models of sugars, sucrose & starch; Quantitative determination of sugars; Paper chromatography for the separation of sugars; Determination of phenols.

SSC-221 Fertilizes and Agro-Chemicals 3(2+1)

Introduction – Raw materials – Manures – Bulky and concentrated- FYM, composts – Different methods, Mechanical compost plants, Vermicomosting, Green manures, Oil cakes, Sewage and sludge – Biogas plant slurry, Plant and animal refuges. Fertilizers – classifications, Manufacturing processes and properties of major nitrogenous (ammonium sulphate, urea, calcium ammonium nitrate, ammonium sulphate nitrate) phosphatic (single super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate), potassic and complex fertilizers their fate and reactions in the soil, Secondary and micronutrients fertilizers, Amendments. Fertilizer Control Order, Fertilizer storage; Biofertilizers and their advantage, Organic chemistry as prelude to agro chemicals, Diverse types of agrochemicals, Botanical insecticides (Neem), Pyrethrum, Synthetic pyrethroids. Synthetic organic insecticides, Major classes, Properties and uses of some important insecticides under each class. Herbicides – Major classes – Properties and uses of 2, 4-D, atrazine, glyphosate, butachlor benthiocarb; Fungicides – Major classes – Properties and uses of carbendazim, carboxin, captain, tridemorph and copper oxychloride – Insecticides Act, Plant growth regulators.

Practicals: Total nitrogen and phosphorus in manures/ composts – Ammoniacal and nitrate nitrogen – Water soluble P_2O_5, potassium, calcium, sulphur and zinc contents of fertilizers, COD in organic wastes – Adulteration in fertilizer. Argentimetric and iodometirc titrations – their use in the analysis of lindane metasystox, endosulfan, malathion, copper and sulphur fungicides – Compatibility of fertilizers with pesticides.

SSC-321 Soil Chemistry, Soil Fertility and Nutrient Management 3(2+1)

Soil as a source of plant nutrients. Essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Measures to overcome deficiencies and toxicities. Problem soils – acid, salt affected and calcareous soils, characteristics, nutrient availabilities. Reclamation – mechanical, chemical and biological methods. Fertilizer and insecticides and their effect on soil water and air. Irrigation water – Quality of irrigation water and its appraisal. Indian standards for water quality. Use of saline water for agriculture. Soil fertility – Different approaches for soil

fertility evaluation. Methods, Soil testing – Chemical methods. Critical levels of different nutrients in soil. Plant analysis – DRIS methods, critical levels in plants. Rapid tissue tests. Indicator plants. Biological method of soil fertility evaluation. Soil test based fertilizer recommendations to crops. Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Sources, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions.

Practical: Principles of analytical Instruments and their calibration and applications, Colorimetry and flame photometry. Estimation of available N, P, K, S and Zn in soils, pH, EC, soluble cations and anions in soil water extracts. Lime requirement and gypsum requirement of problem soils. Estimation of N, P and K in plants.

M.Sc. (Ag.) Courses

SSC 501 Soil Physics 3(2+1)

Theory

UNIT I

Scope of soil physics and its relation with other branches of soil science;
soil as a three phase system. UNIT II

Soil texture, textural classes, mechanical analysis, specific surface. UNIT III

Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.

UNIT IV

Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

UNIT V

Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

UNIT VI

Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils. UNIT VII

Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

UNIT IX

Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

UNIT X

Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil

temperature; soil temperature in relation to plant growth; soil temperature management.

Practical

- Mechanical analysis by pipette and international methods
- Measurement of Atterberg limits
- Aggregate analysis - dry and wet
- Measurement of soil-water content by different methods

Measurement of soil-water potential by using tensiometer and gypsum blocks

Determination of soil-moisture characteristics curve and computation of pore-size distribution

Determination of hydraulic conductivity under saturated and unsaturated conditions

- Determination of infiltration rate of soil
- Determination of aeration porosity and oxygen diffusion rate
- Soil temperature measurements by different methods
- Estimation of water balance components in bare and cropped fields

SSC 502 Soil Fertility And Fertilizer Use 4 Crs. (3+1)

Objective

To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory

UNIT I

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. UNIT II

Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation - types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

UNIT III

Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.

UNIT IV

Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT V

Sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

UNIT VI

Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

UNIT VII

Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions.

UNIT VIII

Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management.

UNIT IX

Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical

- Principles of colorimetry
- Flame-photometry and atomic absorption spectroscopy
- Chemical analysis of soil for total and available nutrients
- Analysis of plants for essential elements

SSC 503 Soil Chemistry 3Crs. (2+1)

Objective

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

UNIT I

Chemical (elemental) composition of the earth's crust and soils. UNIT II

Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT III

Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; clay-organic interactions.

UNIT IV

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, ionic activity measurement, thermodynamics, anion and ligand exchange - inner- sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

UNIT V

Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT VI

Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.

UNIT VII

Chemistry of salt-affected soils and amendments; soil pH, EC_e, ESP, SAR and important relations; soil management and amendments.

UNIT VIII

Chemistry and electrochemistry of submerged soils.

Practical

- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, E_h by the use of E_h-pH meter and conductivity meter
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method
- Potentiometric and conductometric titration of soil humic and fulvic acids
- (E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ (E_4/E_6) values at two pH values
- Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
- Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved
- Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

SSC 504 Soil Mineralogy, Genesis, Classification And Survey 3 Crs. (2+1)

Objective

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

UNIT I

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

UNIT II

Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils.

UNIT III

Concepts and definitions of soil, soil profile; Formation and weathering of rocks and mineral, weathering sequences of minerals. Factors of soil formation, soil forming processes.

UNIT IV

Concept of soil individual; soil classification systems - historical developments and modern systems of soil classification with special emphasis on soil taxonomy; application of soil taxonomy.

UNIT V

Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping.

UNIT VI

Landform – soil relationship; major soil groups of India and UP.; land capability and irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical

- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use
- Cartographic techniques
- Land use planning exercises using conventional and RS tools

SSC 505 Soil Erosion And Conservation 3(2+1)

Theory

UNIT I

History, distribution, identification and description of soil erosion problems in India.

UNIT II

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI_{30} index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT III

Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT IV

Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

UNIT V

Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT VI

Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio- economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

- Determination of different soil erodibility indices, percolation ratio, raindrop erodibility index
- Computation of kinetic energy of falling rain drops
- Computation of rainfall erosivity index (EI_{30}) using rain gauge data
- Visits to a watersheds

SSC 506 Soil Biology And Biochemistry 3(2+1)

Theory

UNIT I

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II

Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora.

UNIT III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, basic principles of humus formation.

UNIT IV

Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V

Preparation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI

Biofertilizers – Definition, classification, specifications, method of production and role in crop production.

Practical

- Determination of soil microbial population
- Soil microbial biomass
- Elemental composition, fractionation of organic matter and functional groups
- Decomposition of organic matter in soil
- Soil enzymes
- Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect

SSC 507 Geomorphology And Geochemistry 2 (2+0)

Theory

UNIT I

General introduction to geology and geochemistry, major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India.

UNIT II

Methodology of geomorphology, its agencies, erosion and weathering; soil and physiography relationships; erosion surface of soil landscape.

UNIT III

Geochemical classification of elements; geo-chemical aspects of weathering and migration of elements; geochemistry of major and micronutrients, trace and other human essential elements.

SSC 508 Radioisotopes In Soil And Plant Studies 2 (2+0)

Theory

UNIT I

Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter

UNIT II

Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography

UNIT III

Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in soil & plant studies

UNIT IV

Doses of radiation exposure, radiation safety aspects regulatory aspects, collection, storage and disposal of radioactive wastes

Practical

- Storage and handling of radioactive materials
- Determination of half life and decay constant
- Preparation of soil and plant samples for radioactive measurements
- Setting up of experiment on fertilizer use efficiency and cation exchange equilibria using radioisotopes
- Determination of A, E and L values of soil using ^{32}P/ ^{65}Zn
- Use of neutron probe for moisture determination
- Sample preparation and measurement of ^{15}N enrichment by mass spectrophotometery/ emission spectrometry

SSC 509 Soil, Water And Air Pollution 3(2+1)

Theory

UNIT I

Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT III

Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV

Pesticides – their classification, behavior in soil and effect on soil micro- organisms.

UNIT V

Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide.

UNIT VIII

Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practical

- Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in

effluents

- Heavy metals and pesticides in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety
- Air sampling and determination of particulate matter and oxides of sulphur
- Visit to various industrial sites to study the impact of pollutants on soil and plants

SSC 510 Remote Sensing And Gis Techniques For Soil, Water And Crop Studies 3(2+1)

Theory

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, microwaveradiometers and scanners; fundamentals of aerialphotographs and image processing and interpretations.

UNIT III

Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management.

UNIT IV

Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.

UNIT V

Introduction to GIS and its application for spatial and non-spatial soil and land attributes.

Practical

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photographs and satellite data for mapping of land resources
- Analysis of variability of different soil properties with classical and geo- statistical techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning

SSC 511 Analytical Techniques And Instrumental Methods In Soil And Plant Analysis 2 (0+2)

Practical

UNIT I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation- reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT II

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

UNIT III

Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

SSC 512 System Approaches In Soil And Crop Studies 3(2+1)

Theory

UNIT I

Systems concepts - definitions, general characteristics; general systems theory; systems thinking, systems dynamics, systems behavior and systems study.

UNIT II

Model: definition and types; mathematical models and their types; modeling: concepts, objectives, processes, abstraction techniques; simulation models, their verification and validation, calibration; representation of continuous systems simulation models - procedural and declarative.

UNIT III

Simulation - meaning and threats; simulation experiment, its design and analysis.

UNIT IV

Application of simulation models in understanding system behavior, optimizing system performance, evaluation of policy options under

different soil, water, nutrient, climatic and cultural conditions; decision support system, use of simulation models in decision support system.

Practical

- Use of flow chart or pseudo-code in the program writing
- Writing a small example simulation model program - declarative (in Vensim PLE, Stella or Simile) and procedural (in Java, Fortran, QBasic or V Basic)
- Conducting simulation experiments in DSSAT, WOFOST or EPIC with requirement of report and conclusion

SSC 513 MANAGEMENT OF PROBLEM SOILS AND WATERS 3(2+1)

Theory

UNIT I

Area and distribution of problem soils – acidic, saline and sodic soils; origin of problematic soils, and factors responsible**.**

UNIT II

Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.

UNIT III

Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.

UNIT IV

Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.

UNIT V

Quality of irrigation water; management of brackish water for irrigation; characterization of brackish waters; relationship in water use and quality.

UNIT VI

Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

- Characterization of acid, acid sulfate, salt-affected and calcareous soils
- Determination of cations (Na^+, K^+, Ca^{++} and Mg^{++}) in ground water and soil samples
- Determination of anions (Cl^-, SO_4^{--}, CO_3^{--} and HCO_3^-) in ground waters and soil samples

- Lime and gypsum requirements of acid and sodic soils

SSC 514 Fertilizer Technology 1(1+0)

Theory

UNIT I

Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states; fertilizer control order. UNIT II

Manufacturing processes for different fertilizers using various raw materials, characteristics and nutrient contents.

UNIT III

Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order.

UNIT IV

New and emerging issues in fertilizer technology – production and use of slow and controlled release fertilizers, supergranules fertilizers and fertilizers for specific crops/situations.

SSC 515 Land Degradation And Restoration 1(1+0)

Theory

UNIT I

Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna, biodegradation and environment.

UNIT II

Land restoration and conservation techniques - erosion control, reclamation of salt-affected soils; mine land reclamation, afforestation, organic products.

UNIT III

Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

Ph.D. Courses

SSC 601 Advances In Soil Physics 3(2+1)

Theory

UNIT I

Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system.

UNIT II

Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional water flow.

UNIT III

Theories of horizontal and vertical infiltration under different boundary conditions. Theories of nutrient dynamics in soil.

UNIT IV

Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.

UNIT V
Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.
UNIT VI
Soil crust and clod formation; structural management of puddled rice soils; soil conditioning- concept, soils conditioners - types, characteristics, working principles, significance in agriculture.
UNIT VII
Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

SSC 602 Advances In Soil Fertility 3(2+1)

Theory
UNIT I
Modern concepts of nutrient availability; soil solution and plant growth;
nutrient response functions and availability indices. UNIT II
Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.
UNIT III
Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils.
UNIT IV
Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.
UNIT V
Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.
UNIT VI
Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.
UNIT VII
Organic residues as plant nutrient sources; crop residues, GM, green leaf manuring, compost, FYM and other concentrated organic manures

SSC 603 Physical Chemistry of Soils 2(2+0)
Theory
UNIT I
Colloidal chemistry of inorganic and organic components of soils - their formation, clay organic interaction.
UNIT II
Predictive approaches for cation exchange equilibria - thermodynamics, empirical and diffuse double layer theory (DDL) - relationships among different selectivity coefficients; structure and properties of diffuse double layer.
UNIT III
Nutrient transformations in soils; cationic and anionic exchange and interaction in soil.

UNIT IV

Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

UNIT V

Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

SSC 604 Soil Genesis And Micropedology 2(2+0)

Theory

UNIT I

Evolution and composition of Earth: Division of Earth sphere, composition of earth crust, relative abundance of rocks in the earth crust

UNIT II

Weathering and soil formation – factors and pedogenic processes; Pedogenesis and taxonomy of Indian soils.

UNIT III

Assessment of soil profile development by morphological, mineralogical and chemical analysis.

UNIT IV

Micro-pedological features of soils – their structure, fabric analysis, role in genesis and classification.

SSC 605 Biochemistry of Soil Organic Matter 3(2+1)

Theory

UNIT I

Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.

UNIT II

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

UNIT III

Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.

UNIT IV

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes.

UNIT V

Humus - pesticide interactions in soil, mechanisms.

SSC 606 Land Use Planning And Watershed Management 2(2+0)

Theory

UNIT I

Concept and techniques of land use planning; factors governing present land use.

UNIT II

Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

UNIT III

Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production. Status of

LUP in India

UNIT IV

Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

UNIT V

Watershed development/management - concept, objectives, characterization, planning,execution, community participationand evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

SSC 607 Advances In Soil Microbiology 3(2+1)

Theory

UNIT I

Microbial and biochemical indicators of soil health – microbial population, MB-C, MB-N, MB-P, soil respiration and soil enzymes

UNIT II

PGPR-mechanism, concern microbes, quality parameters, interaction among them and with plant pathogens, bioformulations of biofertilziers

UNIT III

Molecular study of Rhizobium – legume symbiosis

UNIT IV

Mirobial biodiversity of soil, soil DNA and metagenomic

UNIT V

Important microbial process in soil, microbial interaction in soil, nitrification inhibitors

SSC 608 Advanced Instrumental Techniques 3(2+1)

Theory

UNIT I

Electrochemical techniques: Conductimeter, Karl Fishcer auto titrator, Ion meter

UNIT II

Spectrometric techniques: UV-VIS spectrophotometer, Flame Photometer, Atomic absorption spectrophotometer, ICP-AES and ICP-MS, IR-spectrophotometer and NMR

UNIT III

Chromatographic techniques: HP-TLC, GLC, HPLC, ion-chromatography and electrophoresis techniques

UNIT IV

Thermal techniques: Thermogravimetry (TG), Differential thermal analysis (DTA) and pyrolysis

Experiential Learning Modules
B.Sc. (Ag.) Part - IV, Semester-II

Module I - Crop Production	
Course code	**Course title**
AGR (E) 421 5(0+5)	**Integrated Farming System**
AGR(E) 422 5(0+5)	**Water Management (Watershed, Micro-irrigation, Utilization of problematic water)**
***GPB (E) 421 5(0+5)**	**Seed Production Technology**
SSC (E) 421 5(0+5)	**Biofertilizer**
*Cross listed with AGR	

MODULE –II CROP PROTECTION, APICULTURE & MUSHROOM CULTURE	
Course code	**Course title**
EAZ (E) 421 5(0+5)	**Apiculture**
***EAZ (E) 422 5(0+5)**	**Bio-control Agents and Bio-pesticides**
MPP (E)-421 5(0+5)	**Mushroom Culture**
****SSC(E)422 5(0+5)**	**Soil and Plant Health Clinic**
Cross listed with * MPP ** MPP, EAZ, & PPH	

Module –III: HORTICULTURE	
Course Code	**Course title**
HOR(E)-421 5(0+5)	**Hi-tech Horticulture**
HOR (E)-422 5(0+5)	**Commercial Floriculture**
HOR (E)-423 5(0+5)	**Nursery Management of Horticultural Crops**
HOR(E)-424 5(0+5)	**Commercial Vegetable Production**

Module –IV: Basic Science	
	Course title
GPB (E)-422 5(0+5)	**Molecular Breeding**
****GPB(E)-423 5(0+5)**	**Microbial Technology**
GPB (E)-424 5(0+5)	**Recombinant DNA Technology**
***PPH(E)-421 5(0+5)**	**Plant Tissue Culture**
Cross Listed with GPB & HOR** * Cross Listed with MPP & SSC**	

Module V: Agri-business Management	
Course Code	**Course title**
AEC(E)-421 5(0+5)	**Marketing Management**
AEC(E)-422 5(0+5)	**Financial Management of Agri-business**
EXT(E)-421 5(0+5)	**Project Formulation, Evaluation and Monitoring**
EXT(E)-422 5(0+5)	**Information and Communication Management**

Module VI: Processing and Value Addition	
Course Code	**Course title**
ENG(E)-421 5(0+5)	**Processing and Value Addition of Cereals**
ENG (E)-422 5(0+5)	**Processing and Value Addition of Pulses and Oilseeds**
***ENG (E)-423 5(0+5)**	**Processing and Value Addition of Fruits, Vegetables and Dairy products**
****ENG (E)-424 5(0+5)**	**Processing and Value Addition of Aromatic Plants and Spices**
*** Cross listed with HOR & AHD** ****Cross listed with SSC.**	

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DETAILS OF EXPERIENTIAL LEARNING COURSES

MODULE –I (CROP PRODUCTION)

AGR(E)-421-Integrated Farming System 5(0+5)

UNIT-I Terminology used in farming systems: Crop system, cropping system, Cropping pattern, Farming system, Specialized farming system (SFS), integrated Farming System (IFS)

UNIT-II Indices used in cropping systems and their application under field conditions: equivalent yield, system productivity, system profitability, land use efficiency, man days, net return, B: C ratio, land equivalent ratio, relative area time equivalent ratio, crowding co-efficient, competitive ratio, aggressiveity, actual yield loss, monetary advantage.

UNIT-III Farming system research: Concept, principles and objectives; steps involved in FSR.

UNIT-IV Integrated farming system: Goals, advantages and components. Integrated farming systems for different agro-climatic zones.

UNIT-V Development of Integrated farming system modules for small and marginal farmers under rainfed and irrigated eco-system.

Management of different components of IFS under actual field conditions: crop dairy, fishery, poultry backyard poultry, mushroom, orchard, value addition, year round production of green fodder, NADEP and vermicompost.

AGR(E) 422 -Water Management (Watershed, Micro-irrigation, Utilization of problematic water) 5(0+5)

UNIT-I I dentification, handling, precaution and use of different instruments used in water management.

UNIT-II Soil moisture measurement: Soil moisture content (field method, gravimetric and volumetric method, neutron scattering method, time-domain reflectometry and capacitance sensor method) ; Soil moisture constants- field capacity, permanent wilting point and ultimate wilting point in soil (tensiometer, resistance block, pressure plate apparatus, psychrometer)

UNIT-III Rainfall measurement by rain gauge and problems on calculation of effective rainfall. Measurement of ET by lysimeter, field experimental plots, soil moisture depletion studies, open pan evaporimeter, and climatological (Thornwaite Blaney – Criddle, Pennam, Modified

Pennam) methods.

UNIT-IV Scheduling of Irrigation by different methods viz., IW/CPE ratio, soil-cum sand mini plot technique. Problem on calculation of water use efficiency and water requirement in different crops/cropping system. Irrigation management under scarce water situations.

UNIT-V Measurement of irrigation water by direct (velocity area, flow meter, average cross section, trajectory measurement) and constriction flow (weirs, flumes, orifice) methods. Demonstration of surface, drip, sprinkler irrigation system and water saving technologies.

UNIT-VI Sewage water standards and laboratory determination of water quality (viz electrical conductivity, cations and anions, acidity/basicity, sodium absorption ratio) and their management.

UNIT-VII Drainage: Drainage coefficient, drainage requirement, preparation and maintenance of surface and subsurface drainage system. Hydrological unit of India, process of delineation of water shed and water shed management at micro-level.

3. *GPB (E)-421 Seed Production Technology 5(0+5)

(Cross listed with AGR)

UNIT-I: Test for genuineness of variety/hybrid and parental lines of important crops : Characterization of hybrids, varieties and parental lines through DUS testing & molecular markers, varietal identification through electrophoresis; Grow out test (GOT)

Seed testing : Seed sampling, seed heterogeneity, moisture test, physical purity analysis, determination of other species, genetic purity test, germination test, viability test, seed vigour test, seed health test, coated test, tolerance value, real value of seed, calculation of seed requirements of various crops based on test values.

UNIT-I: Seed production & processing : General principles and methods of seed production, maintenance of nucleus and breeder's seed, hybrid seed production techniques.

Seed production techniques of major field crops and vegetables. Layout of seed processing plant, seed blending, conditioning, seed drying, seed cleaning, grading.

Seed treatment, bagging and storage : Seed priming, treatment for breaking dormancy, Bacterial culture treatments, chilling treatment for vernilization effect, seed treatment for control of insect pest and disease, method of bagging, method of seed storage.

UNIT-I: Seed certification and legislation : Method of seed certification, field inspection, minimum certification standards, seed law enforcement, the protection of plant varieties and farmer's right

act. Seed bill.

Visit to Seed Processing Units

SSC (E)-421 Biofertilizer **5(0+5)**

UNIT I- Prospects of biofertilizers in India agriculture.

UNIT II- Microorganisms used as biofertilizer. Isolation of *Rizobium, Azotobacter, Azospirillum* and phosphate solubilizers in soils.

UNIT III- Identification, testing and selection of efficient strains.

UNIT IV- Quality of carrier materials. Preparation of carrier and liquid bacterial bio fertilizers formulation.

UNIT V- Testing of biofertilizers quality. Inoculation techniques, preparation of BGA and mycorrhizal cultures.

MODULE –II (CROP PROTECTION APICULTURE & MASROOM CULTUR)

EAZ (E) -421-Apiculture 5(0+5)

UNIT I- Apiculture – Scopes and prospects.

UNIT II- Identification, morphology, life history and structural adaptations of bees. Distinguishing bee castes.

UNIT III- Bee keeping appliances.

UNIT IV- Handling of honey bees – Hive and frame inspection. Apiary management practices – General colony management during different seasons. Recognition of bee pasturage.

UNIT V- Identification and management of bee pests and diseases.

UNIT VI- Honey extraction and processing. Other hive products – bees wax, pollen, bee venom, propolis and royal jelly – methods extraction and uses. Role of bees in cross pollination – their exploitation –

UNIT VII- **C**ase studies with selected crops.

UNIT VIII- Production and marketing of quality, honey and value added honey products.

UNIT IX- Effect of agricultural inputs on bee activity – Symptoms of pesticide poisoning Visit to bee nursery and commercial apiaries.

2. *EAZ(E)-422-Bio-control Agents and Bio-pesticides 5(0+5)

Cross listed with MPP

UNIT I- Identification of common natural enemies (parasitoids, predators and pathogens) of crop pests and weeds.

UNIT II- Biology- parasitization/predatory potential of common parasitoids and predators.

UNIT III- Pathogenicity of virus, bacteria and fungi.

UNIT IV- Compatibility of biocontrol with botanicals and chemical pesticides.

UNIT V- Mass production of predators, parasitoids and pathogens. Experiments to show the effect of Semiochemicals in host selection.

UNIT VI- Field release of biocontrol agents in the rice/sugarcane/pigeonpea/chickpea/ mustard/tomato. Mass production of prebaceous mits, Visit to National/Commercial biocontrol laboratories.

MPP (E)-421- Mushroom Culture **5(0+5)**

Unit–I Preparation of culture media for mushrooms, preparation of mushroom culture by tissue culture and by spore print techniques, identification of edible and poisonous mushrooms, microbial contamination during spawn making and their solutions.

Unit–II Preventive measures adopted for mushroom spawn laboratory, layout of mushroom farm, mushroom spawn production.

Unit-III Formulation of compost and casing materials, preparation of compost by long and short methods, Compost suppliments, cultivation methods of white button mushroom (*Agaricus bisporus*) and oyster mushroom (*Pleurotus* spp.)

Unit-IV Cultivation method of milky (*Calocybe indica*), paddy straw (*Volvariella* spp.) and medicinal mushroom (*Ganoderma lucidum*), Preservation and processing of mushrooms.

Unit-V Identification and management of diseases of white button and oyster mushroom, insect pests, mites and nematodes of mushrooms, biotic abnormalities of mushrooms and their management. Observation and measurement of growth and yield of mushrooms. Improvement of mushroom strain and preparation of mushroom recipes.

*SSC(E)-422-Soil and Plant Health Clinic 5(0+5)

Cross listed with (MPP, EAZ & PPH)

UNIT-I Collection of soil sample using G.P.S. and its processing. Soil testing for fertilizer recommendation. Soil testing for diagnosis of problems viz., salinity, sodicity, acidity etc. Survey and collection of plant samples related to nutritional disorders and their diagnosis.

UNIT-II Technique for collection & storage of plant samples. Ashing of plant samples. Ash analysis for different elements. Wet digestion of plant samples. Analysis of different elements in plant samples by chemical method. Flame photometry & atomic absorption spectrophotometer. Creation of deficiency & toxicity of some elements in crop plants & their tissue analysis.

UNIT- III Survey and collection of insect infested and diseased sample from various crops. Diagnosis of different insect pests and diseases. Seed health testing before sowing. Identification of new insect pests and plant pathogens.

MODULE –III HORTICULTURE

1. HOR(E)-421-Hi-tech Horticulture 5(0+5)

UNIT-I Nursery raising of high value flower and vegetable crops.

Off- season plants/plantlets production of horticultural crops.

Plant production in low cost in polythene bags and in plastic perforated trays.

Familiarization with construction materials of low cost shade nets and polyhouse.

Greenhouse design, structure and technology for production of high quality planting materials.

UNIT-II Use of various media in horticultural crops.

Raising foliage plants in low cost structures.

High density planting and management of horticultural crops.

Micro-irrigation and fertigation in horticultural crops.

Organic farming in horticulture.

UNIT-III Production of Gerbera under protected condition.

Production of cut roses in greenhouse.

UNIT-IV Hi-tech plant protection/IPM strategies in horticultural crops.

Recent developments in post-harvest management.

UNIT-V Standards and grades in horticultural produce and products.

Sanitary and phytosanitary measures for horticultural crops.

Knowledge about logistics and policies for Hi-tech horticulture.

UNIT-VI Visit to the Hi-tech horticulture units.

Visit to the Flower Export Oriented Units.

HOR(E)-422-Commercial Floriculture 5(0+5)

UNIT-I Identification of tools and implements

UNIT-II Nursery raising of flower crops

UNIT-III Bed preparation for rose cultivation

Selection of rose varieties and planting techniques

Care and management of rose plants

Harvesting and handling of rose flowers

UNIT-IV Selection of Gladiolus varieties, corms and corms treatment & planting techniques

Care and management of Gladiolus

Harvesting of Gladiolus spike, grading and post harvest management

Harvesting of corms, cleaning grading and storage

Field preparation for marigold cultivation

UNIT-V Marigold seedling treatment and transplanting

Pinching and weeding of marigold field

Marigold flower harvesting, grading and value addition of marigold

UNIT-VI Production of filler crops

Seed production of important flower crops

Production techniques of annual and perennial chrysanthemum

Value addition and flower arrangements

Production techniques of tuberose

UNIT-VII Identification of pot plants, cut greens, foliage, succulents, high value foliages and palm, etc.

UNIT-VIII Visit to commercial flower production farm.

HOR (E)-423-Nursery Management of Horticultural Crops 5(0+5)

UNIT-I Method of plant propagation, sexual and asexual.

Layout of Model nursery of fruit crops.

Nursery and layout of annuals and perennials ornamental plants.

UNIT-II Crop calendar and nursery raising in vegetable crops.

Testing of seed viability and germination.

Seed treatment, stratification and scarification.

Use of plant growth regulators.

UNIT-III Raising root stock and propagules (Papaya) through seeds.

Multiplication of plants by cutting, layering, budding and grafting.

Propagation by modified root and stem.

UNIT-IV Propagation media, sterilization and bed preparation.

Plant propagation structure; net house, poly house, cold frame and hot frame.

UNIT-VI Hi-tech nursery and plant propagation through plugged plants.

UNIT-VII Lifting, packing, transport and marketing of nursery plants.

UNIT-VIII Visit to commercial nursery.

UNIT-IX Nursery Acts and Registration.

HOR(E)-424-Commercial Vegetable Production **5(0+5)**

UNIT-I Different vegetable crops grown in India and preparation of vegetable calendar Identification of implements for vegetable gardening

UNIT-II Preparation of nursery bed(raised and flat bed) and seed/ soil treatment Raising of nursery of tomato, brinjal, chilli, onion cabbage and cauliflower

UNIT-III Selection of site and layout of the field
Application of manures and fertilizers
Transplanting /sowing of important vegetable crops
Development of irrigation schedule

UNIT-IV Application technique of herbicides, insecticides and fungicides
List of improved varieties of vegetable crops
List of important hybrid varieties of vegetables

UNIT-V To study the mode of reproduction in vegetable crops
Study the floral biology of vegetable crops

UNIT-VI Development of vegetable hybrid seeds

UNIT-VII Identification of warm season vegetable crops

UNIT-VIII Application techniques of plant growth substances and micronutrients
Determination of maturity indices in vegetable crops
Cost benefit ratio of different vegetable crops

UNIT-IX Techniques of seed production of important vegetable crops
Harvesting, cleaning, sorting, grading, and packaging of seeds
Prescribed field/ seed standards for vegetable seed production

UNIT-X Visit to commercial vegetable farm

MODULE –IV Basic Science

GPB(E)- 422 Molecular Breeding **5(0+5)**

UNIT-I: Introduction to molecular plant breeding related laboratory equipments

UNIT-II: Demonstration of developed mapping population

UNIT-III: DNA isolation protocols

UNIT-IV: Handling of PCR

UNIT-V: Electrophoresis procedure

UNIT-VI: Computer based analysis of gel bands for mapping

***GPB (E)-423 Microbial Technology** **5(0+5)**
(Cross listed with MPP & SSC)

UNIT-I Isolation and cultivation of microorganisms (bacteria, fungi and algae)

UNIT-II MPN of *Azospirillum and Rhizobium.* Isolation of *Azotobacter* and PSM from typical soil.

UNIT-III Staining techniques and its application in identification.
Media formulation, microbial culture selection and optimization of fermentation process.

UNIT-IV Estimation of growth of bacteria using various methods. Determination of growth rate & generation time.

UNIT-V Evaluation of symbiotic nitrogen fixing ability in Rhizobium-legume association.

UNIT-VI Isolation of Pseudomonas fluorescens its mass production and delivery system.
Estimation of phytohormone production & phosphate solubilization.

GPB(E) 424 Recombinant DNA Technology (GPB) **5(0+5)**

UNIT-I Introduction to recombinant DNA technology & handling laboratory tools and equipments

UNIT-II Bacterial culture (*Agrobacterium*) procedure

UNIT-III DNA isolation, purification and quantification

UNIT-IV Agarose gel electrophoresis

UNIT-V PCR-machine (Thermocycler) and its application

UNIT-VI Blotting techniques

PPH(E)-421-Plant Tissue Culture (GPB, HORT. & PPH.) **5(0+5)**
*****Cross listed with GPB & HOR

UNIT-I Basic requirements and knowledge of various equipments/accessories. Historical Perspectives.
Media preparation and sterilization techniques.

(a)- Media such as MS, Gamborges. Preparation stock solution.

(b)- Glassware and explants sterilization.

Induction of callus from different parts of germinating seedlings.

Organ cultures *in-vitro.*

Hormonal applications and micropopagation of selected ornamental and medicinal plant using different ex-plants:

(a) - Nodal segments

(b) – Shoot tips.

Abiotic stress tolerance in-vitro: salinity, drought etc.

UNIT-II Initiation of suspension culture, its measurement, selection of mutant cells *in vitro* from culture cells.

Embryogenesis in carrot culture

Micropopagation of turmeric/ginger/potato/banana

Isolation of virus free plant of potato/tomato/tobacco

Protoplast culture and somatic hybridization: isolation of protoplast and fusion of protoplast from two different plant species.

Anther pollen and embryo culture from rice: induction of androgenic callus, haploid production, colchiplodization.

Genetic transformation

Cryopreservation of important plant materials.

UNIT-III Regeneration protocol for:

(a) Ornamental crops: dahlia, chrysanthemum, tuberose, orchids, rose, carnation and gerbera.

(b) Fruit crops: banana, strawberry

(c) Vegetable crops: Asparagus, potato, sweet potato

Ovary and embryo culture for regeneration of interspecific crosses of horticultural crops. Anther culture (Cauliflower, broccoli, chillies, tomato, brinjal) and double haploid regeneration.

Visite to commercial micropopagation unit.

MODULE –V Agri-business Management

AEC (E)-421 Marketing Management 5(0+5)

Unit-I : Visit to regulated, cooperative and unregulated markets and preparation and presentation of project report.

Unit-II: Visit to organized retail market, corporate market and preparation and presentation of project report.

Unit-III: Visit of agro-based industries and documentation of marketing process, collection of marketing information.

Unit-IV: Documentation of product processing,

Unit V: Types of packaging materials used for packing of different products.

Unit-VI: Study of marketing channels.

Unit-VII: Marketing research, time series analysis, future trading etc.

AEC (E)-422 Financial Management of Agri-Business 5(0+5)

Unit – I: Visit to commercial banks, regional rural banks, NABARD, Cooperatives, NCDC and other financing agencies and preparation and presentation of report.

Unit – II: Visit to investment institution i.e. LIC, GIC, mutual funds, commercial bank, non-banking financial companies (NBFC), Agro-industries (Corporation, IDBI, IFCI, ICICI,SFCs, SIDCs) and micro-finance institution and preparation and presentation of report.

Unit – III: Preparation and presentation of financial statements-balance sheet, income statement, funds flow statement, cash flow statement.

Unit – IV: Financial statement analysis and presentation: ration analysis, time series analysis, common size analysis, du-pont-analysis, breakeven analysis, difficulties associated with financial statement analysis.

Unit – V: Analysis and presentation of capital budgeting, payback period, average rate of return, net present value, benefit cost ratio, internal rate of return.

EXT (E)-421 Project Formulation, Evaluation and Monitoring 5(0+5)

UNIT-I Fundamentals of Project formulation and management: Procedure

for application, Project Description, Funding Information, Project Management.

UNIT-II Area survey and data collection: Guidelines for Data collection, Socio-economics Survey Formate.

UNIT-III Model project proposal formulation: Preparation of Project, Designing Covering Letter, Preparation of Budget Estimate.

UNIT-IV The logical Framework Approach to Project Planning: Basics of Logical Framework Approach (LFA), Understanding LFA terms, Advantage of LFA.

UNIT-V Collection of project application formats: Information about Implementing Agency, Information about Project. Application formats of various funding agencies.

UNIT-VI Monitoring and evaluation of project: Concept of Monitoring and Evaluation, Procedure of Evaluation.

EXT (E) 422 Information and Communication Management 5(0+5)

UNIT-I Concept and rationale for Information Management in Agriculture in general and Agricultural Extension in particular;

UNIT-II The history of Information Communication Technologies for Development (ICT4D); Issues related to ICT4D; Cyber Extension; Computer Literacy, Information Literacy, Media Literacy, ;

UNIT-III ICT enabled initiatives for Agricultural Development at National and international level; Success stories of ICT use in rural India; Hole in the wall, cybermohalla, wall project, mapping the neighbourhood;

UNIT-IV Market intelligence for farmers; Role of ICT in Entrepreneurship Development in Agriculture; Market survey and financial analysis of projects; Business management; Case studies of ICT application by farmers;

UNIT-V Organisational support for extension functionaries for ICT application in Extension service; User friendly software's for Extension professionals;

UNIT-VI Hands on sessions for learning software packages; Project preparation by students;

UNIT-VII ICT mediated Knowledge management Experiments; Creation of crop

specific knowledge models and portals for effective management of information.

MODULE –VI Bio Processing and Value Addition

ENG(E)-421 Cereals Processing 5(0+5)

UNIT-I: Determination of moisture content using oven method. Determination of moisture content using moisture meter.

UNIT-II: Unit operation for processing of paddy such as cleaning, grading, milling. Rice milling – traditional and modern methods.

UNIT-III: Performance studies of separation methods. Determination of milling quality of paddy influenced by milling parameters.

UNIT-IV: To study different products from wheat.

UNIT-V: To study the storage characteristics of cereals such as rice, wheat. Visit to rice milling plants.

ENG(E)-422 Pulses and Oilseeds Processing 5(0+5)

UNIT-I: To study the physical properties of pulses and oilseeds. Determination of moisture content using oven method. Determination of moisture content using moisture meter.

UNIT-II: Unit operations such as cleaning, grading, drying, milling of pulses and oilseeds. Performance studies of separation methods. Performance studies on grading equipment.

UNIT-III: Determination of milling quality of pulses influenced by milling parameters. Determination of oil expression/extraction quality of oilseeds influenced by different parameters.

UNIT-IV: To study the storage characteristics of pulses and oilseeds. Visit to Dal mill and Oil mill.

*ENG(E)-423 Fruits, Vegetables and Dairy Products Processing 5(0+5)

Cross Listed with HOR & AHD

UNIT-I: To study the physical properties of fruits and vegetables. Study of separation methods. Drying of fruits and vegetables. Performance study of fruits/vegetables washer and green pea sheller.

UNIT-II: Performance study of peeler. Load deformation characteristic of fruits/vegetables. To study the production of fruit juice, RTS and juice concentrate by using RO system.

UNIT-III: To study the production of squash, jelly, jam, marmalades, pickles, cordial, tomato and potato products and bio-safety concerns. Comparative study of packaging materials for fruits and vegetables and their products.

UNIT-IV: To study the storage characteristics of fruits and vegetables-common storage, zero energy cool chamber, cold storage, controlled atmosphere storage, modified atmosphere storage. Visit to fruit/vegetable factory. Visit to cold storage.

UNIT-V: To study processing of milk, production of traditional dairy products and improvement in their packaging. Visit of Dairy Plant.

ENG (E)-424 Aromatic Plants and Spices Processing 5(0+5)

(Cross listed with SSC)

UNIT-I Collection and grading of medicinal and aromatic plants (roots, bark, leaf, flower and seeds). Processing of medicinal plant parts: air drying, over (hot air) drying, lypholization and grinding. Extraction of active parts: solvent extraction (soxhlet extraction), sonication, blending and super critical fluid extraction.

UNIT-II Formulation and bottling of bioactive constituents of plants. Testing of active ingredients: steroid, terpenoids, flavonoid and alkaloid. Collection and preservation of active parts of aromatic plants. Extraction of essential oils from aromatic plants: expression, distillation and solvent extraction. Bottling of essential oil. Analysis of chemical constituents of essential oils.