

## Resolution

We the undersigned convenors of the following P.G. Subjects have re-structured the respective courses as per ICAR latest guidelines on the meeting held on 16/07/2018 at Center for Academic, C.S.J.M. University, Kanpur


1. Agricultural Economics
2. Genetics & Plant Breeding
3. Horticulture
4. Agronomy
5. Agriculture Entomology
6. Plant Pathology
7. Agricultural Extension
8. Soil Science & Agricultural Chemistry
9. Soil Conservation

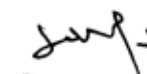
The nomenclature of earlier Ag. Botany & Ag. Chemistry be changed as Genetics & Plant Breeding, Soil Science & Agriculture Chemistry respectively in view of existing Subjects names in other Universities.

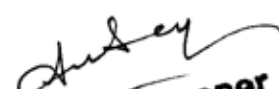
The restructured syllabus of the above courses are submitted for your kind approval w.e.f 2019-2020.

  
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 Horticulture

  
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 Convenor  
 Ag. Botany

  
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 Soil Science  
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**Common Course for M Sc (Ag) all Subjects****CA-502 COMPUTER APPLICATION IN AGRICULTURE (1+1)****Theory**

Introduction to Computers, Operating Systems, definition and types, Applications of MS-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture, World Wide Web (WWW): Concepts and components. Introduction to computer programming languages, concepts and standard input/output operations.

e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smart phone Apps in Agriculture for farm advises, market price, post harvest management etc; Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning using IT tools.

**Practical**

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix/ Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific Document. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri- information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

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**Common Course for M Sc (Ag) all Subjects****AS-501 Agricultural Statistics Agricultural Statistics (2+1)****Theory****Unit-1**

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 distribution: Binomial, Poisson, Normal distribution. 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 coefficient, partial correlation coefficient, multiple correlation coefficient, rank correlation coefficient test of significance of correlation coefficient and regression coefficients, coefficient of determination.

**Unit IV**

Need for designing of experiments, characteristics of a good design. Basic principles of designs, randomization, replication and local control.

**Unit V**

Uniformity trials, size and shape of plots and blocks, analysis of variance, completely randomized design, randomized block design and Latin square design, missing plot techniques, split plot design.

**Unit VI**

Sampling techniques - Planning of survey, method of data collection, questionnaire v/s schedule, Problems of sampling frame, choice of sample of design, probability sampling, sample space, sampling design, simple random sampling, Estimation of proportion, confidence interval, Determination of sample size, stratified sampling, cluster sampling, multi state sampling, systematic sampling, ratio and regression method of estimation, Non sampling error-source and classification.

**Practical**

On the topic listed on the theory syllabus.

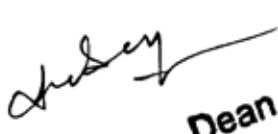
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## M.Sc. (Ag.) Agricultural Economics

### Course Structure – At a Glance

AGECON 501*	Micro Economics Theory and Application	3(3+0)
AGECON 502*	Macro Economics Theory and Policy	3(3+0)
AGECON 503*	Evaluation of Economic Thought	3(3+0)
AGECON 504*	Agricultural Production Economics	3(2+1)
AGECON 505*	Agricultural Marketing and Price Analysis	3(2+1)
AGECON 506*	Research Methodology for social sciences	3(2+1)
AGECON 507*	Econometrics	3(2+1)
AGECON 508*	Linear Programming	2(1+1)
AGECON 509*	Agricultural Finance and Project Management	3(2+1)
AGECON 515	Rural Marketing	3(2+1)
AGECON 591	Master's Seminar	1(1+0)
AGECON 599	<b>Master's Thesis</b>	<b>20</b>
	OR	
	<b>Special Papers (following courses may be taken to fulfill the requirements)</b>	<b>20</b>
AGECON 510	International Economics	4(3+1)
AGECON 511	Agricultural Development and Policy	4(4+0)
AGECON 512	Institutional Economics	4(4+0)
AGECON 513	Natural Resources and Environmental Economics	4(3+1)
AGECON 516	Commodity Future Trading	4(4+0)
Minor	Since no related PG programmes are running in the concerned colleges other enlisted optional courses may be taken to fulfill the requirements.	9
Supporting Course	Agricultural Statistics	3(2+1)
	Computer Application in Agriculture	2(1+1)
<b>COMPULSORY NON –CREDIT COURSES enlisted in the last part of the syllabus may be taught in association with other running courses in the college.</b>		

\*Compulsory for master's programme

  
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## M.Sc. (Ag.) Agricultural Economics

### Semester wise Course Distribution

First Semester		Evaluation Marks				
Course No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 501*	Micro Economics Theory and Application	3(3+0)	50	-	50	100
AGECON 504*	Agricultural Production Economics	3(2+1)	20	30	50	100
AGECON 505*	Agricultural Marketing and Price Analysis	3(2+1)	20	30	50	100
AS-501	Agricultural Statistics	3(2+1)	20	30	50	100
	<b>Total credit hours</b>	<b>12</b>				

Second Semester		Evaluation Marks				
Course No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 502*	Macro Economics Theory and Policy	3(3+0)	50	-	50	100
AGECON 506*	Research Methodology for social sciences	3(2+1)	20	30	50	100
AGECON 508*	Linear Programming	2(1+1)	20	30	50	100
AGECON 515	Rural Marketing	3(2+1)	20	30	50	100
	<b>Total credit hours</b>	<b>11</b>				

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Third Semester		Evaluation Marks				
Course No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 503*	Evaluation of Economic Thought	3(3+0)	50	-	50	100
AGECON 507*	Econometrics	3(2+1)	20	30	50	100
AGECON 509*	Agricultural Finance and Project Management	3(2+1)	20	30	50	100
CA 502	Computer Application in Agriculture	2(1+1)	20	30	50	100
	<b>Total credit hours</b>	<b>11</b>				

Fourth Semester		Evaluation Marks				
Course No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
AGECON 591	Master's Seminar	1(1+0)				100
AGECON 599	Master's Thesis	20	Satisfactory/Unsatisfactory			
OR Special Papers		20				
AGECON 510	International Economics	4(3+1)	Satisfactory/Unsatisfactory			
AGECON 511	Agricultural Development and Policy	4(4+0)				
AGECON 512	Institutional Economics	4(4+0)				
AGECON 513	Natural Resources and Environmental Economics	4(3+1)				
AGECON 516	Commodity Future Trading	4(4+0)				
	<b>Total credit hours</b>	<b>21</b>				

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## M.Sc. (Ag.) AGRICULTURAL ECONOMICS

### COURSE CONTENT - DETAILED SYLLABUS

#### AGECON 501 MICRO ECONOMIC THEORY AND APPLICATIONS 3(3+0)

**Objective:** This course is intended to provide an overview of microeconomic theory and its applications. The course starts with the theory of consumer behaviour consisting of consumer's utility maximization problem and demand theory. It intends to provide fundamental concepts and models in the theory of production and costs and sets out to provide a basic understanding of price and / or output determination under different types of market structures including factor markets. This course will also expose the students to the theory of general equilibrium and welfare economics.

#### 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 - Behaviour 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.

#### AGECON 502 MACRO ECONOMICS THEORY AND POLICY 3(3+0)

**Objective:** Macro economics and Policy course is intended to expose the students to macroeconomic concepts and theory, the application of the macro economic theory, and implication of the macroeconomic policies.

#### Theory

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**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.

**AGECON 503      EVOLUTION OF ECONOMIC THOUGHT****3 (3+0)**

**Objective:** To introduce the students to the evolution of economic thought over a period of time, the background of emanation of thoughts and approaches, as acts of balancing and counter balancing events and criticisms. The course will also in a comprehensive way help the students to know and appreciate the contributions of the Galaxy of Economists.


**Theory****UNIT I**

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**


  
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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.

**AGECON 504**

**AGRICULTURAL PRODUCTION ECONOMICS 3(2+1)**

**Objective:** To expose the students to the concept, significance and uses of agricultural production economics.

#### 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.

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**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.

### **AGECON 505 AGRICULTURAL MARKETING AND PRICE ANALYSIS 3(2+1)**

**Objective:** To impart adequate knowledge and analytical skills in the field of agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities.

#### **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.

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**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.

#### **AGECON 506 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES 3(2+1)**

**Objective :** To expose the students to research methodology used in social sciences. The focus will be on providing knowledge related to research process, data collection and data analysis etc.

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**

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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.

**AGECON 507**

**ECONOMETRICS**

**3 (2+1)**

**Objective:** The Course Objective of the course is to impart knowledge on econometric tools to the students of agricultural economics. Training in econometrics will help the student to analyse the economic problem by applying quantitative techniques.

**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.

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**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.

**AGECON 508**

**LINEAR PROGRAMMING**

**2(1+1)**

**Objective:** To provide knowledge of linear programming technique to solve the various problem of given objective.

**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.

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

**Objective:** The Course Objective of the course is to impart knowledge on issues related to lending to priority sector credit management and financial risk management. The course would bring in the various appraisal techniques in project - investment of agricultural projects.

**Theory**

#### **UNIT I**

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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.

   
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**Objective:** The expected outcome of this course will be creating awareness among the students about the role of International Economics on National welfare.

**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**

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..

**AGECON 511 AGRICULTURAL DEVELOPMENT AND POLICIES**

**4(4+0)**

**Objectives** • to provide orientation to the students regarding the concepts and measures of economic development • to provide orientation on theories of economic growth and relevance of theories in developing countries. • to make them to understand the agricultural policies and its effect on sustainable agricultural development • to make them to understand the globalization and its impact on agricultural development.

**Theory**

**UNIT I**

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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. 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.

AGECON 512

INSTITUTIONAL ECONOMICS

4(4+0)

**Objective** The course exposes the students to the institutional problems and remedies.

### 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.

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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.

### AGECON 513 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS 4(3+1)

**Objectives** • To introduce economics principles related to natural resource and environmental economics • To explore the concept of efficiency and the efficient allocation of natural resources • To understand the economics of why environmental problems occur.

• To explore the concept of efficiency and the efficient allocation of pollution control and pollution prevention decisions. • To understand the environmental policy issues and alternative instruments of environmental policies.

### 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

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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.

AGECON 515

RURAL MARKETING

3(2+1)

**Objective:** To provide understanding regarding issues in rural market like marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

#### Theory

#### UNIT I

Concept and scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India.

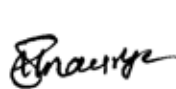

#### UNIT II

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

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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.

**Practical:** Survey of rural market both primary and secondary, case study of marketing of a minor and major commodity with respect to rural marketing channels, costs, margin and market price spread, market performance and rural market efficiency. On line searches for rural market information sources and interpretation of market intelligence report, submission of a report on above all aspects.

AGECON 516

COMMODITY FUTURES TRADING

4 (4+0)

**Objective :** This course is aimed at providing the basic understanding and the mechanics and value of futures markets for speculators and hedgers who in turn will serve as price risk management activities of agribusiness firms.

#### 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.

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# M.Sc. (Ag.) GENETICS AND PLANT BREEDING

## Course Structure – at a Glance

GP 501*	Principles of Genetics	3(2+1)
GP 502*	Principles of Cytogenetics	3(2+1)
GP 503*	Principles of Plant Breeding	3(2+1)
GP 504*	Principles of Quantitative Genetics	3(2+1)
GP 505	Mutagenesis and Mutation Breeding	3(2+1)
GP 506	Population Genetics	3(2+1)
GP 507	Heterosis Breeding	3(2+1)
GP 508*	Cell Biology and Molecular Genetics	3(2+1)
GP 509*	Biotechnology for Crop Improvement	3(2+1)
GP 510	Breeding for Biotic and Abiotic Stress Resistance	3(2+1)
GP 511	Breeding Cereals, Millets and Sugarcane	3(2+1)
GP 512	Breeding Legumes, Oilseeds and Fibre Crops	3(2+1)
GP 515	Maintenance Breeding, Concept of Variety Release and Seed Production	2(1+1)
GP 591	Master's Seminar	1(0+1)
GP 599	<b>Master's Thesis</b>	<b>20</b>
	<b>OR</b>	
	<b>Special Papers (any additional courses enlisted optional courses or following courses may be taken to fulfil the requirements )</b>	<b>20</b>
GP 513	Breeding for Quality Traits	4(3+1)
GP 514	Gene Regulation and Expression	4(4+0)
GP 517	Data Base Management, Evaluation and Utilization of PGR	4(3+1)
GP 595	Experimental Designs in Plant Breeding	4(3+1)
GP 596	Innovative Approaches for Crop Improvement	4(4+0)
Minor	Since no related PG programmes are running in the concerned Colleges other enlisted optional courses may be taken to fulfil the requirements.	9
Supporting Course	Agricultural Statistics	3(2+1)
	Computer Application in Agriculture	2(1+1)
<b>COMPULSORY NON-CREDIT COURSES</b> enlisted in the last part of the syllabus may be taught in association with other running courses in the college.		

\*Compulsory for Master's programme

*Dr. Rojeev Kumar*  
(Dr. Rojeev Kumar)  
Convener

*Dean*  
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*Ajay Kumar*  
(A. Ajay Kumar)



# M.Sc. (Ag.) Genetics and Plant Breeding

## Semester wise Course Distribution

First Semester						
Course No.	Course Title	Credit Hours	Marks			Total
			Theory	Practical	Mid Term	
GP 501*	Principles of Genetics	3(2+1)	50	30	20	100
GP 502*	Principles of Cytogenetics	3(2+1)	50	30	20	100
GP 503*	Principles of Plant Breeding	3(2+1)	50	30	20	100
AS 504	Agricultural Statistics	3(2+1)	50	30	20	100
	<b>Total Credit Hours</b>	<b>12</b>				

Second Semester						
Course No.	Course Title	Credit Hours	Marks			Total
			Theory	Practical	Mid Term	
GP 504*	Principles of Quantitative Genetics	3(2+1)	50	30	20	100
GP 505	Mutagenesis and Mutation Breeding	3(2+1)	50	30	20	100
GP 506	Population Genetics	3(2+1)	50	30	20	100
GP 507	Heterosis Breeding	3(2+1)	50	30	20	100
GP 508*	Cell Biology and Molecular Genetics	3(2+1)	50	30	20	100
GP 512	Breeding Legumes, Oilseeds and Fibre Crops	3(2+1)	50	30	20	100
	<b>Total Credit Hours (Minimum)</b>	<b>12</b>				

Third Semester						
Course No.	Course Title	Credit Hours	Marks			Total
			Theory	Practical	Mid Term	
GP 509	Biotechnology for Crop Improvement	3(2+1)	50	30	20	100

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GP 510	Breeding for Biotic and Abiotic Stress Resistance	3(2+1)	50	30	20	100
GP 511	Breeding Cereals, Millets and Sugarcane	3(2+1)	50	30	20	100
GP 515	Maintenance Breeding, Concept of Variety Release and Seed Production	2(1+1)	50	30	20	100
CA 502	Computer Application in Agriculture	2(1+1)	50	30	20	100
	<b>Total Credit Hours (Minimum)</b>	<b>10</b>				

<b>Fourth Semester</b>						
Course No.	Course Title	Credit Hours	Marks			Total
			Theory	Practical	Mid Term	
GP 591	Master's Seminar	1(0+1)				100
GP 599	Master's Thesis	<b>20</b>	Satisfactory/Unsatisfactory			
<b>OR Special Papers</b>		<b>20</b>				
GP 513	Breeding for Quality Traits	4(3+1)	Satisfactory/Unsatisfactory			
GP 514	Gene Regulation and Expression	4(4+0)				
GP 517	Data Base Management, Evaluation and Utilization of PGR	4(3+1)				
GP 595	Experimental Designs in Plant Breeding	4(3+1)				
GP 596	Innovative Approaches for Crop Improvement	4(4+0)				
	<b>Total Credit Hours</b>	<b>21</b>				

\*Compulsory for Master's programme

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# M.Sc. (Ag.) GENETICS AND PLANT BREEDING

## COURSE CONTENT – DETAILED SYLLABUS

### GPB 501: PRINCIPLES OF GENETICS

3(2+1)

#### THEORY

##### UNIT I

Beginning of genetics; Cell structure and cell division; Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.

##### UNIT II

Multiple alleles, Gene interactions. Sex determination, 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.

##### UNIT V

Classical and modern gene concept; Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

##### UNIT VI

Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, 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; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

##### UNIT VIII

Gene silencing; genetics of mitochondria and chloroplasts.

##### UNIT IX

Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioral genetics.

#### PRACTICAL

Laboratory exercises in probability and chi-square ( $\chi^2$ ); Demonstration of genetic principles using laboratory organisms; Numerical exercise related to Mendelian Principles; Numerical related to multiple alleles (ABO blood group system), Chromosome mapping using three-point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; 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; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

##### UNIT II

Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of

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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 and Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids; Utilization of aneuploids in gene location; Evolutionary significance of chromosomal aberrations; balanced, lethal and chromosome complexes.

### 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 postfertilization 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 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; Studies on the course of meiosis in cereals, millets, pulses and in oilseeds; 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; Morphological observations on synthesized autopolyploids; Morphological observations on allopolyploids; Morphological observations on aneuploids; Cytogenetic analysis of interspecific and intergeneric crosses; Maintenance of Cytogenetic stocks and their importance in crop breeding.

## GPB 503: PRINCIPLES OF PLANT BREEDING

3(2+1)

### THEORY

#### UNIT I

History of Plant Breeding; 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; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

#### UNIT III

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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 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; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites; Hybrid breeding 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.

### UNIT VI

Breeding for abiotic and biotic stresses

### UNIT VII

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.

## GPB 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 D2 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.

### Practical

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D2 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. Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) – use of software in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model.

## **GPB 505: MUTAGENESIS AND MUTATION BREEDING**

**3(2+1)**

### **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: Ionizing and non-ionizing radiations viz., X rays,  $\gamma$  rays,  $\alpha$  and  $\beta$  particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations 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, Radiation sensitivity and modifying factors: External and internal sources.

#### **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; Other causes of mutation - direct and indirect action.

#### **UNIT V**

Observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras *etc.*; Observing mutagen effects in M2 generation; Estimation of mutagenic efficiency and effectiveness

#### **UNIT VI**

Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage; Individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation.

#### **UNIT VII**

Use of mutagens in creating oligogenic and polygenic variations; Handling of segregating generations and selection procedures; Validation of mutants; Mutation breeding for various traits in different crops; Procedures for micro-mutations breeding/polygenic mutations; Achievements of mutation breeding-varieties released across the world- Problems associated with mutation breeding.

#### **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; 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; Study of M1 generation – Parameters to be observed; Study of M2 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 M2 and M3 generations.



**GPB 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.

**UNIT III**

Multiple alleles; More than one locus; Use of gene and genotypic frequencies evaluation in field population level; Interpretations - Changes of gene frequency; Migration, Mutation, Recurrent and non-recurrent selection; 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; Effect of inbreeding and sibbing in cross pollinated crops.

**UNIT V**

Gene substitution; Breeding value- Genetic drift; Genetic slippage, Co-adapted gene complexes; Homoeostasis; Adaptive organization of gene pools, 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- Cavalli's joint scaling test; Exercises of different mating designs; Estimation of different population parameters from experimental data.

**GPB 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; Theories of heterosis: Genetic, Physiological, and Biochemical; Evolutionary concepts and estimation of heterosis.

**UNIT III**

Prediction of heterosis from various crosses; Inbreeding depression, frequency of inbreeding and residual heterosis in F<sub>2</sub> 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 self-incompatibility 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.

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**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**

Creation of male sterility through genetic engineering and its exploitation in heterosis.

**UNIT VII**

Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum 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 oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them; 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.

**GPB 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, plastids chloro/chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

**UNIT II**

Bioenergetics; Ultrastructure and function of mitochondria; 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.

**UNIT IV**

DNA content variation, types of DNA sequences - Unique and repetitive sequences; organelle genomes; Gene amplification and its significance.

**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; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell.

**GPB 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.

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**UNIT III**

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs and ESTs), mapping populations.

**UNIT IV**

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Gene pyramiding.

**UNIT V**

Marker assisted selection and molecular breeding; Genomics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding.

**UNIT VI**

Recombinant DNA technology, transgenes, method of transformation, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, Sugarcane, Commercial releases.

**UNIT VII**

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

**UNIT VIII**

GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights.

**UNIT IX**

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, Construction of genetic linkage maps using computer software.

**GPB 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 defense responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis.

**UNIT II**

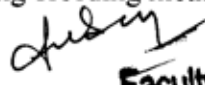
Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance; Measuring plant resistance using plant fitness.

**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.

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**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; 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; 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 for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance; Phenotypic screening methods for diseases caused by fungi and bacteria; Quality parameters evaluation; Screening crops for drought and flood resistance; Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies.

**GPB 511: BREEDING CEREALS, MILLETS 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; 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 objectives, quality characters, biotic and abiotic stress resistance, exploitation of heterosis.

**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.

**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.

**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; QPM and Bt maize – strategies and implications.

**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.

**UNIT V**

Distinguishing features of popular released varieties in Rice, Wheat, Sorghum, Pearl millet, Maize and Sugarcane 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 software for database management and retrieval.

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**GPB 512: BREEDING PULSES, 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; Breeding objectives- yield, quality characters, biotic and abiotic stress; 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; Protein quality improvement; Breeding for anti-nutritional factors.

**UNIT III**

**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.

**UNIT IV**

**Rapeseed and Mustard:** Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress; Oil quality characteristics in different oils; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

**Sunflower:** Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

**UNIT V**

**Cotton:** Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress; Development and maintenance of male sterile lines; Hybrid development and seed production; Scenario of Bt cottons, evaluation procedures for Bt cotton.

**UNIT VI**

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 Chickpea; Use of descriptors for cataloguing – Floral biology, emasculation, pollination techniques in Rapeseed and Mustard.

**GP 513: BREEDING FOR QUALITY TRAITS****4(3+1)****THEORY****UNIT I**

Genetics of carbohydrates, proteins, fats, vitamins, and anti-nutritional factors; Breeding for grain quality parameters in rice and its analysis, Golden rice and aromatic rice; Breeding strategies, achievements and application in Indian context.

**UNIT II**

Breeding for baking qualities in wheat; Characters to be considered and breeding strategies; Molecular and cytogenetic manipulation for quality improvement in wheat.

**UNIT III**

Breeding for quality improvement in Sorghum and pearl millet; Quality protein maize – Concept and breeding strategies; Genetic resource management for sustaining nutritive quality in crops.

**UNIT IV**

Breeding for quality in chickpea and pigeonpea; Breeding for quality in rapeseed and mustard, groundnut, and sunflower and minor oilseeds; Genetic manipulation for quality improvement in cotton.

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**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; Quality parameters evaluation in wheat; Quality parameters evaluation in pulses and Quality parameters evaluation in oilseeds; Value addition in crop plants ; Post harvest processing of major field crops.

**GP 514: GENE REGULATION AND EXPRESSION****4(4+0)****THEORY****UNIT I**

Introduction: Gene regulation-purpose; Process and mechanisms; Levels of gene controls.

**UNIT II**

Coordinated genetic regulation-examples- Anthocyanin and gene families and maize; Genetic and molecular basis depending on tissue specificity.

**UNIT III**

Gene expression-Transposons in plant gene expression, cloning-transposon tagging; Light regulated gene expression-model systems in *Arabidopsis* and maize; Paramutations and imprinting of genes and genomes.

**UNIT IV**

Transgene expression and gene silencing mechanisms; Regulatory genes, horizontal and vertical homology; Transformation-regulatory genes as visible markers; Reporter systems to study gene expression; Combinatorial gene control.

**UNIT V**

Eukaryotic transcriptional control; Translational and post-translational regulation; Signal transduction; Stress-induced gene expression; Gene traps and enhancer traps.

**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, paddy, pearl millet, sorghum, maize ); Pulses (pigeonpea, chickpea, fieldpea); Oilseeds (groundnut, sunflower, rapeseed and mustard); fibre (cotton) 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.

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**GP 517: DATA BASE MANAGEMENT, EVALUATION  
AND UTILIZATION OF PGR**

**4(3+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; Estimation of sample size for storage and viability testing.

**UNIT II**

Germplasm documentation; Basics of computer and operating systems; Database management system, use of statistical softwares, pictorial and graphical representation of data.

**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.

**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.

**GP 595: EXPERIMENTAL DESIGNS PLANT BREEDING**

**4(3+1)**

**UNIT I**

Principles of experimental design, precision and accuracy, advantage of replication, experimental technique. Analysis of variance, fundamental principles of analysis of variance. Critical difference, Limitations of the analysis of variance.

**UNIT II**

Statistical analysis and advantage and disadvantage of basic design-Completely Randomized Design, Randomized Block Design, Latin Square Design.

**UNIT III**

Split plot design.

**UNIT IV**

Missing plot technique; Bartlett's techniques for missing plots, cross-overdesign or switch-over trials, Rotational experiments, progeny selection, compact family block design, uniformity trial, sampling in field experiments.

**Practical**

Analysis of data generated from completely randomized design, randomized block design; Latin square design, Split plot designs, Missing plot techniques, Analysis of covariance, Sampling in field experiments.

**GP 596: INNOVATIVE APPROACHES IN PLANT BREEDING**

**4(4+0)**

**THEORY**

**UNIT I**

Introduction, Markers: morphological, isozymes, DNA markers (RFLP, RAPD, AFLP, SSR, SNP). Construction of linkage map; use of mapping populations (F2, RILs, NILs, back cross, doubled haploids)-applications, advantages, constraints. Applications of molecular markers; finger printing,

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phylogenetic relationships. Tagging agronomically important traits. Assessing heterotic performance; Marker assisted selection (MAS) for oligogenic traits, MAS for QTLs. Gene pyramiding using molecular markers.

#### UNIT II

Transgenic plants; applications of transgenic technology, molecular farming, antisense RNA technology, stability of transgenes, integration of transgenics in plant breeding.

#### UNIT III

Biosafety issues of transgenics. Somatic hybridization applications and constraints. Somaclonal variation in crop improvement; overview and future prospects.

#### UNIT IV

Plant genetic resources - characterization and utilization. Breeding for biotic stress resistance, abiotic stress tolerance and nutritional quality. Apomixis and its utilization.

#### UNIT V

Functional markers, Reverse genetics approaches: Targeting Induced Local Lesions IN Genomes (TILLING), ECOTILLING and its application in crop breeding.

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**M.Sc.(Ag.) Horticulture**

I <sup>st</sup> Semester			Evaluation Mark			
Code No.	Course Title	Credit Hours	Mid Term	End Term	Practical	Total
HORT 501	Propagation and Nursery Management for Fruit Crops	3(2+1)	20	50	30	100
HORT 502	Land Scaping and Ornamental Gardening	3(2+1)	20	50	30	100
HORT 503	Tropical and Dry Land Fruit Production	3(2+1)	20	50	30	100
AS 501	Agricultural Statistics	3(2+1)	20	50	30	100
	Total Credit	12				
II <sup>nd</sup> Semester			Evaluation Mark			
Code No.	Course Title	Credit Hours	Mid Term	End Term	Practical	Total
HORT 504	Production Technology of cool season Vegetable Crops	3(2+1)	20	50	30	100
HORT 505	Subtropical and Temperate fruit production	3(2+1)	20	50	30	100
HORT 506	Production Technology of cut and loose flowers	3(2+1)	20	50	30	100
HORT 508	Protected Cultivation of Horticultural Crops	2(1+1)	20	50	30	100
	Total Credit	11				
III <sup>rd</sup> Semester			Evaluation Mark			
Code No.	Course Title	Credit Hours	Mid Term	End Term	Practical	Total
HORT 507	Production Technology of warm season Vegetable Crops	3(2+1)	20	50	30	100
HORT 509	Breeding of Horticultural Crops	3(2+1)	20	50	30	100
HORT 510	Post Harvest Technology for Horticultural Crops	3(2+1)	20	50	30	100
CA 502	Computer Application in Agriculture	2(1+1)	20	50	30	100
	Total Credit	11				
IV <sup>th</sup> Semester			Evaluation Mark			
Code No.	Course Title	Credit Hours	Mid Term	End Term	Practical	Total
HORT 591	Master Seminar	1(0+1)	-	-	-	100
HORT 599	Master Research (Thesis)	20	Satisfactory			100
OR						
HORT 511	Fruit Technology (Special Paper)	4(3+1)	20	50	30	100
HORT 512	Production Technology of Medicinal Aromatic Crops (Special Paper)	4(3+1)	20	50	30	100
HORT 513	Production Technology of Plantation and Spice Crops (Special Paper)	4(3+1)	20	50	30	100
HORT 514	Advance Horticulture	4(3+1)	20	50	30	100
HORT 515	Production Technology of under utilize Sub-tropical crops.	4(3+1)	20	50	30	100
	Total Credit	21				
	Total Credit Hours	55				

**Compulsory non-credit courses enlisted in the last part of the syllabus may be taught in association with other running courses.**

**M.Sc. (Ag.) Horticulture****I<sup>st</sup> Semester****PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS****3(2+1)****HORT 501****Ist Semester****Theory UNIT I**

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixes, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

**UNIT II**

- ✓ Seed quality, treatment, packing, storage, certification, testing. Asexual propagation-rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

**UNIT III**

Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock relationship-incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

**UNIT IV**

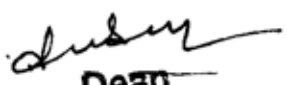
Micro-propagation-principles and concepts, commercial exploitation in horticultural crops. Techniques – in vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

**UNIT V**

Nursery-types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

**Practical** Anatomical studies in rooting of cutting and graft union. construction of propagation structures, study of media and PGR. Hardening –case studies, micropropagation, explant preparation, media preparation. culturing – in vitro clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro

  
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grafting, hardening. Visit to TC labs and nurseries.

**I<sup>st</sup> Semester**

**HORT 502**

**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, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

**UNIT III**

Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.

**UNIT IV**

Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.

**UNIT V**

Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

**Practical** Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, 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.

**I<sup>st</sup> Semester**

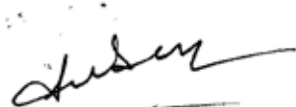
**HORT 503**

**Tropical And Dry Land Fruit Production**

**3(2+1)**

**Theory** Comercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock

  
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influence, planting systems, cropping systems, root zoon and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, pest and diseases management physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, industrial and export potential, Agri. Export Zones (AEZ) and industrial supports.

UNIT I – Mango and Banana

UNIT II – Citrus and Papaya

UNIT III – Guava, Sapota and Jackfruit

UNIT IV – Pineapple, Annonas and Avocado

UNIT V – Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

**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 commercial orchards.

#### II<sup>nd</sup> Semester

HORT 504

#### 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, knoll kohl, sprouting broccoli, Brussels sprout.

Unit III – Root crops: carrot, radish, turnip and beetroot

Unit IV- Bulb crops: onion and garlic.

Unit V- Peas and broad bean, green leafy cool season vegetables.

#### Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economic; Experiments to demonstrate the role of mineral elements, plant growth substances and

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herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/polyhouse.

HORT 505

II<sup>nd</sup> Semester

3(2+1)

**SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION**

**Theory**

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, industrial and export potential, Agri Export Zone (AEZ) and industrial support.

**Crops**

Unit I- Apple, pear, quince, grapes

Unit II- Plums, peach, apricot, cherries, hazelnut

Unit III- Litchi, loquat, persimmon, kiwifruit, strawberry

Unit IV- Nuts-walnut, almond, pistachio, pecan

Unit V- Minor fruits-mangosteen, carambola, baobab, wood apple, fig, jamun, rambutan, pomegranate.

**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.

II<sup>nd</sup> Semester

HORT 506

**PRODUCTION TECHNOLOGY OF CUT AND LOOSE FLOWERS 3(2+1)**

**Theory UNIT I**

Scope of cut and loose flowers in global trade, Global Scenario of cut and loose flower production, Varietal wealth and diversity, area under cut and loose flowers and production problems in India-Patent rights, nursery management, media for nursery, special nursery practices.

**UNIT II**

Growing environment, open cultivation of cut and loose flower, soil

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requirements, field preparation, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO<sub>2</sub> on growth and flowering.

#### UNIT III

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 IV

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, prolonging self life, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops: Rose, chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, lilliums, as cut flower nyctanthes, jaismine, marigold, crosandra, celosia, gamphrena as loose flower.

**Practical** Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, dirp and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut and loose flowers, visit to commercial flower units and case study.

#### III<sup>rd</sup> Semester

#### PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS

3(2+1)

HORT 507

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, reconomics of crop production and seed production of :

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Unit I- Tomato, eggplant, hot and sweet pepers

Unit II – Okra, beans, cowpea and clusterbean

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 substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

#### III<sup>rd</sup> Semester

**HORT 508**      **PROTECTED CULTIVATION OF HORTICULTURAL CROPS**      **2(1+1)**  
Theory      Unit I-

Importance and scope of protected cultivation, world scenario Indian situation present and future scope. Principles used in protected cultivation, energy management, low cost structures;

#### Unit II-

Regulatory structures used in protected structure types of greenhouse/polyhouse/nethouse, hot beds, cold frames, effect of environmental factors viz temperature, light, CO<sub>2</sub> and humidity on growth of different vegetables, flowers and fruits. manipulation of CO<sub>2</sub> light and humidity and temperature for production of horticultural crops installation of micro irrigation and fertilization.

#### Unit III

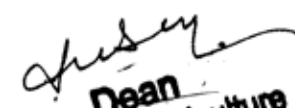
Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.

#### Unit IV

Regulation of flowering and fruiting in horticultural crops, technology for raising tomato, sweet pepper, cucumber, crops, Jherbera, rose, chrysanthemum and straw berry in protected structures training and staking in protected crops, varieties and hybrids suitable for growing in protected structures.

#### Unit V

  
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Problem of growing horticultural crops in protected structures and their remedies, insect and disease management in protected structures;

**Practical**

Study of various types of structures, methods to control temperature, CO<sub>2</sub> and light, media, training and pruning, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in the region.

**HORT 509**

**III<sup>rd</sup> Semester  
BREEDING OF HORTICULTURAL CROPS**

**3(2+1)**

~~Objectives~~

~~Students principles and practices adopted for breeding~~

**Theory** Origin, botany, taxonomy, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, Issue of patenting, PPVFR act, achievement and future trust in following selected crops.

**Unit I**

Mango, papaya, banana, grape and citrus fruits.

**Unit II**

Potato, tomato, brinjal, hot pepper and sweet pepper.

**Unit III**

Okra, Pea and beans.

**Unit IV**

Gourds, melons, pumpkins and squashes

**Unit V**

Cabbage, cauliflower, carrot, beetroot, radish.

**Practical**

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, fananological studies, selfing and crossing techniques in horticulture crops; hybrid seed production of vegetable 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.

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**III<sup>rd</sup> Semester**  
**HORT 510 POST HARVEST TECHNOLOGY FOR 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, transpiration.

**Unit II**

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest losses horticultural crops, pre-cooling. Spoilage, microbial and biochemical physical injuries and disorders.

**Unit III**

Treatments prior to transportation, viz. grading, precoding chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage-ventilated, refrigerated, MAS, CA storage zero energy cool chamber, hypobaric storage

**Unit IV**

Packing methods and transport, principles and methods of preservation, food processing, canning preparation of fruit juices, ~~pickles, jams, jellies, candies and tomato products~~

**Unit V**

Dried and dehydrated products, nutritionally enriched products, fermented beverages, packaging technology management of processing waste, 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.

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**4<sup>th</sup> Semester**  
**( HORT 511 )**  
**FRUIT TECHNOLOGY (Special Paper)**

**Unit I :**

History, present position and future scope of fruit and vegetables preservation industries in India. General principles of fruit and vegetables preservation.

**Unit II :**

Canning and bottling of fruit and vegetables, brief history of scientific canning equipment for home. canning and commercial production, important consideration for laying out of canny. Canning of important fruits, vegetables, spoilage in canned fruits and vegetables.

**Unit III :**

Fruits and vegetables juices, unfermented beverages [sweetened and unsweetened], principles of preservation, home and commercial scale equipment for juices, preparation and preservation of juices, squashes and Cardials from Citrus fruits, Mango, Phalsa, Jamun, Grape, Pomegranate, Tomato etc. Fruit juice concentrates and their general method of preparation.

**Unit IV :**

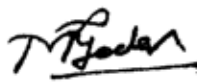
Jams, Jellies and Marmalades, role of pectin-sugar and acid in jelly formation, general method of preparation of jams, jellies and marmalades, use of jelly meter etc. Equipment for home and commercial production.


**Unit V :**

Pickles, sauces, chutney and Vinegar, Potato chips general principles equipment and method of preparation, preserve candy and canes fruits, general principles and method of preparation of byproduct from fruit and vegetables waste in home and commercial production and sun drying and dehydration of fruit and vegetables, equipment and methods.

**Practical –**

- 1) List of important equipments for fruit and vegetable preservation .
- 2) Preparation of Jam, Jelly, Marmalade and Pickles (Mango, Lime and Mix Veg.).
- 3) Preparation of Beverages (RTS, Squash, Nectar, Syrup and Barley Water) .
- 4) Preparation of preserve and candy (Aonla , Bael and Karaunda).
- 5) Preparation of Tomato products (Sauce , Ketchup and chutney).
- 6) Preparation of Potato Chips and canning of Pea.

  
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## 4<sup>th</sup> Semester

(HORT 512)

### Production Technology of Medicinal and Aromatic Crops. (Special Paper)

#### Unit- I :

Importance and scope of medicinal and aromatic crops in India and future prospects, classification of medicinal and aromatic crops.

#### Unit- II :

Cultivation of medicinal crops like Rauvolfia, Dioscoria, Alovera, Safed Musli, Stevia, Isabgol, Ashwagandha and Asparegus.

#### Unit- III :

Cultivation of Aromatic crops like Mentha, Javacitronella, Khus, Ocimum, Chamomile, Lemon grass, Geranium, Palmarosa and Rose.

#### Unit IV :

Special problems of Medicinal and Aromatic crops and their control.

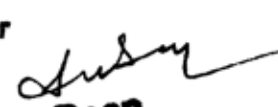
#### Unit- IV :

Different method of distillation of medicinal and aromatic crops, problems of distillation and there solution. Marketing of medicinal and aromatic crops.

#### Practical-

- 1) Identification of medicinal and aromatic crops.
- 2) Study of propagation techniques of medicinal and aromatic crops.
- 3) Study of cost of production of Rauvolfia, , Alovera, Safed Musli, Mentha, Turmeric and Ginger .
- 4) Study of different method of distillation of medicinal and aromatic crops.
- 5) Visit of distillation plant and institute related to medicinal and aromatic crops.

  
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## 4<sup>th</sup> Semester

(HORT 513)

### Production Technology of Plantation and spice crops (Special Paper)

#### Unit I :

Importance and scope of Plantation and Spice crop in India, its area and distribution.

#### Unit II :

Production technology of Plantation crops like, Coconut, Areca nut, Cashew nut, Tea, Coco and Coffee.

#### Unit III :

Production technology of Spice crops like Turmeric, Zinger, Cumin, Coriander, Fennel, Black Paper, Cardamom (Large and small).

#### Unit IV :

Propagation techniques of Plantation and spice crops.

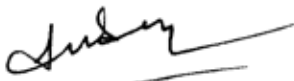
#### Unit V :

Problems of Plantation and spice crop and their remedies. Marketing, Post harvest management and storage of plantation and spice crops.

#### Practical –

- 1) Identification of Plantation and spice crops.
- 2) Propagation methods of plantation crops.
- 3) Preparation of nursery for Plantation crops.
- 4) Calculation of cost of production per hectare of spice crops- Turmeric, Zinger, Coriander and Cumin.

  
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## 4<sup>th</sup> Semester

(HORT 514)

### Advance Horticulture (Special Paper)

#### Unit I :

Introduction and importance, mechanization of Nursery. Micro Propagation of Horticulture Crops. Advantages and limitations. Types of culture (Seed, embryo, organ, callus en cell).

#### Unit II :

Advances made in root stocks. Development of root stocks for biotic and abiotic stress.

#### Unit III :

Advances in irrigation system. Advantage and disadvantage of drip irrigation, sprinkler and rain gun.

#### Unit IV :

Canopy management of Tropical and Subtropical fruit crops like Mango, Guava, Grapes, Ber and Beal.


#### Unit V :

Special problem of fruit crops and there control(Mango, Guava, Papaya, Grapes, Pine apple and Apple). High density orcharding in fruits crops.

#### Practical –

- 1) Identification and use of equipments in tissue culture laboratory..
- 2) Sterilization technique of media.
- 3) Identification and application of tools and equipment related to micro irrigation system and canopy management.
- 4) Identification of special problems of fruit crops.

  
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## 4<sup>th</sup> Semester

(HORT 515)

### Production Technology of Under utilize Sub-tropical Fruits (Special Paper)

#### Unit I :

Importance and scope of under utilize fruits in India. Distribution and description of under utilize fruits.

#### Unit II :

Production technique of under utilize sub-tropical fruits like Beal, Carambola, Custard apple, Wood Apple, Tamarind, Lasora, Barbadas cherry, Chirounji, Jamun, Falsa, Fig, Mulberry, Karounda, Barhal and Amra.

#### Unit III:

Propagation technique of under utilize fruits sexual and asexual including micro propagation.

#### Unit IV :

Problem of under utilize fruits and their remedies.

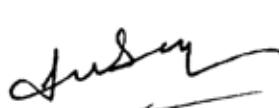
#### Unit V :

Marketing, Post harvest management and storage of under utilize fruits.

#### Practical –

- 1) Identification of under utilize fruits.
- 2) Propagation of under utilize fruits.
- 3) Filling and Lifting of poly bags.
- 4) Packaging of sapling.
- 5) Visit of Research centers working on under utilize fruits.

  
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**Department of Agronomy**  
**C S J M University, Kanpur**

**Courses for Master Degree Programme in Agronomy**

Code	Course Title	Credit hrs
<b>Major Courses</b>		
<b>1<sup>st</sup> Semester</b>		
AGR-501	Modern concept in crop production	3(3+0)
AGR-503	Principles and practices of weed management	3(2+1)
AGR-506	Scientific cultivation of major cereals and pulses	3(2+1)
AS-501	Agricultural Statistics	3(2+1)

**2<sup>nd</sup> Semester**

AGR-504	Principles and practices of water management	3(2+1)
AGR-507	Scientific cultivation of oilseed, fiber and sugar crops	3(2+1)
SAC-502	Soil fertility and fertilizer use	4(3+1)
SAC-504	Soil Mineralogy, Genesis, Classification and Survey	3(2+1)

**3<sup>rd</sup> Semester**

AGR-502	Principles and practices of soil fertility and nutrient management	3(2+1)
CA-502	Computer Application in Agriculture	2(1+1)
SAC-509	Soil water and air pollution.	3(2+1)
AGR-510	Physiology of Growth and yield and modeling	3(2+1)

**4<sup>th</sup> Semester**

AGR-509	Scientific cultivation of fodder and forage crops	3(2+1)
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Seminar		1(0+1)
Thesis		20
<b>Or</b>		
Add five courses each of 4 credits as optional papers		20
<b>Total</b>		<b>60</b>

**Compulsory non-credit courses enlisted in the last part of the syllabus may be taught in association with other running courses.**

**AGRONOMY****M.Sc.(AG.)****Course Contents****AGRON 501 MODERN CONCEPTS IN CROP PRODUCTION****Theory****UNIT -1**

Crop growth analysis in relation to environment, agro-ecological zones of India. agro – climatic zones of U.P. and india.

**UNIT -2**

Quantitative agro-biological principles and inyerse yield nitrogen law, mitscherlich yield equation, its interpretation and applicability; ~~haule~~ Paule unit.

**UNIT -3**

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources.

**UNIT-4**

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

**UNIT-5**

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming determining the nutrient needs for yield potentiality of crop plant; concept of balance nutrition and integrated nutrient management.

**AGRON 502 SOIL FERTILITY AND NUTRIENT MANAGEMENT 2+1****Theory****UNIT -1**

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.

**UNIT-2**

Criteria of essentiality of nutrients; essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

**UNIT-3**

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

**UNIT-4**

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades;

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agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interaction.

#### UNIT-5

Time and method 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 vermicompost and residue wastes in crops.

#### Practical

- Determination of soil pH, E<sub>c</sub>, organic C, total N available N P K and S in soil
- Determination of total N, P, K, and S in plants.
- Numerical problem on fertilizers Requirement and fertilizer mixture.

### ✓ **AGRON 503 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT**

**2+1**

#### Theory

##### UNIT-1

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

##### UNIT-2

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

##### UNIT-3

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

##### UNIT-4

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

##### UNIT-5

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

#### Practical

- Identification of important weeds of different crop
- Preparation of a weed herbarium
- Weed survey in crop and cropping systems
- Crop-weed competition studies
- Preparation of spray solution of herbicides for high and low – volume sprayers
- Economics of weed control
- Herbicides resistance analysis in plant and soil
- Calculation of herbicidal requirement

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**AGRON 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT 2+1****Theory****UNIT-1**

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-2**

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress.

**UNIT-3**

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

**UNIT-4**

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

**UNIT-5**

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crop and methods of field drainage.

**Practical**

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

**AGRON 506 SCIENTIFIC CULTIVATION OF MAJOR CEREALS AND PULSES****2+1****Theory**

Origin and history, area and production, classification improved varieties, adaptability, climate,

Soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of

**UNIT-1**

Rabi cereals: wheat, barley, oat,

**UNIT-2**

Kharif cereals: Paddy, maize, sorghum, bajra

**UNIT-3**

Rabi pulses: chickpea, field pea, lentil, rajmash

**UNIT-4**

Kharif pulses: Arhar, Urd, Moong, cowpea, soybean

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## Practical

- Phenological studies at different growth stages of crop
- Estimation of crop yield on basis of yield attributes
- Formulation of cropping schemes for various farm size and calculation of cropping and rotational intensities
- Planning and layout of field experiments
- Judging of physiological maturity in different crop
- Intercultural operations in different crops
- Determination of cost of cultivation of different crop
- Work out harvest index of various crops.
- Study of seed production techniques in various crop
- Visit of field experiments on cultural, fertilizer, weed control and water management aspects

## AGRON 507 SCIENTIFIC CULTIVATION OF OILSEED, FIBRE AND SUGAR CROPS 2+1

### Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and culture requirement nutrient management, handling and processing of the produce for maximum production of:

#### UNIT-1

Rabi oilseeds – Rapeseed and mustard, linseed.

#### UNIT-

Kharif oilseed – Groundnut, Til, castor, sunflower, soybean.

#### UNIT-3

Fiber crops- cotton, jute sun hemp.

#### UNIT-4

Sugar crop- sugar-beet and sugarcane.

## Practical

- Planning and layout of field experiments
- Cutting of sugarcane setts. It's treatment and methods of sowing, tying and propping of sugarcane
- Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice. Phenological studies at different growth stage of crop
- Intercultural operations in different crops
- Cotton seed treatment
- Working out growth indices (LER, CGR, RGR, NAR, LAD) aggressively, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems
- Judging of physiological maturity in different crops and workout harvest index
- Work out cost of cultivation of different crops
- Estimation of crop yield on the basis of yield attributes
- Study of seeds production techniques in various crops
- Visit of field experiments on cultural fertilizer, weed control and water management aspects

## UNIT-1

Area and distribution, varietal improvement, agro-technique and quality aspects including anti-quality factors of important fodder crop like maize, teosinte(mukchari), sorghum, bajra, guar, cowpea, oats, barley, berseem, lucerne.

## UNIT-2

Area and distribution, varietal improvement, agro-technique and quality aspects including anti-quality factors of important forage crop/grasses, Napier grass, Nandi grass.

## UNIT-3

Year-round fodder production and management, preservation and utilization of forage and pasture crop.

## UNIT-4


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 in poor quality fodder.

## UNIT-5

Economics of forage cultivation uses and seed production techniques.

**Practical**

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

  
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## M.Sc. (Ag) Agricultural Entomology

S. N.	Course Code	Course Name	Credit hrs.	Distribution of Marks	
				Theory (Mid- term exam. + final exam)	Practical Exam.
SEMESTER-I					
1.	AE 501	Insect Morphology	4 (3+1)	(20+50)	30
2.	AE 502	Insect Systematic	3 (2+1)	(20+50)	30
3.	AE 503	Insect Anatomy, Physiology and Nutrition	3 (2+1)	(20+50)	30
4.	AS 501	Agricultural Statistics	3 (2+1)	(20+50)	30
5.	PGS 501	Library And Information Services (Non Gradial 50% Marks Required For Satisfactory)	1(0+1) Non-gradial	(20+50)	30
SEMESTER-II					
6.	AE 504	Insect Ecology	3 (2+1)	(20+50)	30
7.	AE 505	Toxicology of Insecticides	3 (2+1)	(20+50)	30
8.	AE 506	Plant Resistance to Insects	3 (2+1)	(20+50)	30
9.	PGS 505	Agricultural Research, Research Ethics And Rural Development Programmes	2 (2+0) Non-gradial	(20+50)	30
10.	PGS 502	Technical Writing And Communications Skills (Non Gradial 50% Marks Required For Satisfactory)	1(0+1) Non- gradial	Satisfactory/Unsatisfactory 50% marks required for satisfactory grade	
11.	PGS 503	Intellectual Property And Their Application In Agriculture (Non Gradial 50% Marks Required For Satisfactory)	1(1+0) Non- gradial	Satisfactory/Unsatisfactory 50% marks required for satisfactory grade	
12.	AE 507	Integrated Insect Pest Management	3(2+1)	(20+50)	30

SEMESTER-III					
13.	AE 508	Advanced Techniques of Plant Protection	3 (2+1)	(20+50)	30
14.	AE 509	Biological Control	3 (2+1)	(20+50)	30
15.	AE 510	Insect Vectors of Plant Viruses and Other Pathogens	3 (2+1)	(20+50)	30
16.	CA 502	Computer Application in Agricultural	2 (1+1)	(20+50)	30
17.	PGS 504	Basic Concepts In Laboratory Techniques (Non Gradiat 50% Marks Required For Satisfactory)	1 (0+1) <b>Non-gradial</b>	Satisfactory/Unsatisfactory 50% marks required for satisfactory grade	
SEMESTER-IV					
18.	AE 511	Storage Pests and Their Management	3 (2+1)	(20+50)	30
19.	AE 512	Insect of Industrial Importance	3 (2+1)	(20+50)	30
20.		Seminar	1(0+1)	Satisfactory/Unsatisfactory 50% marks required for satisfactory grade	
21.		Project Or Thesis Or Add five courses each of 4 credits as optional paper.	20	Satisfactory/Unsatisfactory	
Compulsory non-credit courses enlisted in the last part of the syllabus may be taught in association with other running courses.					

## COURSES OF M.SC.(AG.) ENTOMOLOGY

### **AE 501 INSECT MORPHOLOGY 3 (2+1)**

Introduction and brief history of entomology (1), Principles; utility and relevance (1), Integument structure, physical colours, outgrowths, appendages, functions (2), structure of insect head (2), appendages, antennae (1) mouthparts and modifications (2) tentorium, neck sclerites (1), Thorax - structure of tergum, sternum and pleuron and pterothorax (2), wings - origin, structure, modification, venation, articulation, wing coupling apparatus (2), Legs - structure, articulation, modification 1, Abdomen - sclerites, pregenital and genital segments, appendages, genitalia (2), Metamorphosis (2),

#### **Practical**

Preparation of permanent and temporary mounts, slides (1) , cuticular outgrowths (1), general morphology of grass hopper (1), Head sclerites, suture , areas , tentorium (2), types of antennae (1), mouthparts and their modifications in grasshopper, honey bee, red cotton bug, thrips, butterfly, house fly, caterpillar (4), Thoracic sclerites (1), wings types and venation (2), wing coupling (1), legs - types (1), abdomen - stinging organ in . bees (1), genitalia (1), Identification of immature stages - types of larvae and pupae (1).

### **AE 502 INSECT SYSTEMATICS 3 (2+1)**

Relationship between systematics and taxonomy (1), Zoological nomenclature and zoological classifications (1), type concept and types at species level, History of insect systematics. Insect phylogeny, current classification (1), Importance of taxonomy and levels of systematics (1 ),concept of species, sub-species, kinds of species and taxonomic keys (1), Principles and application of zoological nomenclature (4), Description of new taxa (1), Classification of different orders up to families of agricultural importance (3).

#### **Practical**

Taxonomic collections, curation of insects (3), Preparation of slides for making illustration (1), Illustrating taxonomic characters (1), Camera Lucida drawing of insects (2), Identification of insect keys (2), Repository of insect collections (1), website visits to museums identification of insects of agricultural importance (1).

### **AE 503 INSECT ANATOMY, PHYSIOLOGY AND NUTRITION 3 (2+1)**

Scope and importance of insect anatomy and physiology (1), Embryonic development (2), Anatomy and physiology of digestive(3), excretory (3), respiratory (2), circulatory (2), nervous (2), endocrine and exoc-rine (2) and reproductive systems (4). Metabolism of carbohydrates, Lipids and nitrogenous compounds (2), Insect nutrition (1), Role of vitamins, proteins, amino acids, carbohydrates, lipids, sterols and minerals in insect nutrition (2), Sensory organs and insect behaviour (2), Metabolism of carbohydrates, lipids and nitrogenous compounds (3).



**Practical**

Dissection of insects to study comparative modifications, digestive, respiratory, nervous and reproductive systems in grass hopper, bugs, flies, bees, beetles, moths, Experiments to study haemocyte count, observations on histology of embryonic stages from permanent to slides, Colorimetric estimation, of uric acid and acetylcholine esterase (4), Paper chromatography of amino acids, pH of insect gut. Preparation of artificial diet of a lepidopteran insect (2).

**AE 504 INSECT ECOLOGY 3 (2+1)**

Basic concepts - population and environment (2), Population regulation - natural control and current theories (2), Characteristics of population (1), Biotic potential and environmental resistance (2), Stable age distribution (1), population dynamics (1), Diapause, hibernation and aestivation (2), Effect of environmental factors on distribution and abundance of insects (2), Food chain and ecological succession (2), Ecological indicators (1).

**Practical**

Measurement of micro-environments (3), Concepts of life table and construction of life tables (4), Computer simulation, modeling (3), Estimates of population density (3), Sampling methods and plans (3), Estimation of dispersion and migration (2).

**AE 505 TOXICOLOGY OF INSECTICIDES 3 (2+1)**

Principal of toxicology (1), Insecticides - their classification (1), Mode of action, structure, activity, relationships of arsenicals, rotenoids, dinitrophenols, fluoro- compounds, chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, nicotenoids, neem products and newer molecules viz. - avermectins (7), metabolism and toxicity (4), synergism, antagonism and compatibility (2), systemic and. selective insecticides (2), Insect resistance to insecticides and resurgence (3), Insecticide residue - their significance, analysis and environmental implications (7), Diagnosis and treatment of insecticide poisoning (2), Plant products (2), Formulations. Rules of insecticide registration and quality control (S). Application techniques and hazards (2).

**Practical**

Preparation of laboratory formulations and standard concentration of insecticides (2), Bioassay technique (4), Testing of relative toxicity and synergism (3), Sampling for insecticide residue, their extraction, cleanup and estimation (3), compatibility of pesticides, phytotoxicity, toxicity to beneficial insects (4), Scrutiny of pesticides. containers with reference to Insecticide Act, 1968, Evaluation of spray particles. Assessment of efficacy of Insecticides under laboratory and field conditions correction for natural mortality, Fixing LDSO, LCSO and L TSO for insecticide. Dragsstedt- Behrens -Graphical and Finney's methods - pro bit analysis.

**AE 506 PLANT RESISTANCE TO INSECTS 3 (2+1)**

History and importance (1), Ecological and genetic resistance (1), Mechanism of plant resistance to insects (2), Factors that affect the expression or permanence of resistance (1), Role of secondary plant substances in host selection (2), Chemoreception (1), phagostimulants (1), Peculiarities of plant

reaction to pest injury (1), Methods of investigating pest resistance (?), Genetics of pest resistance (1), Sources of plant resistance (2), Genetically modified plants for pest resistance (1), Resistance to insects in major crops (2).

**Practical**

Use of planimeter (1), Graphic technique and choice tests for measuring resistance (4), Measurement of plant characters and working out their correlations with plant resistance (3), Testing of resistance in important crops (5), Bioassay of plant extracts of susceptible/resistant varieties (3), Demonstration of antibiosis, preference and non-preference (2).

**AE 507 INTEGRATED INSECT PEST MANAGEMENT 3 (2+1)**

The concept and history of pest management (4), Components of pest management (2), Ecological and socio-economic aspects, cost benefit and risk/benefit ratios (3), Cultural, biological, chemical, genetic, legal and other control tactics and their integration for pest management (6), Sampling and measuring the economic levels of damage, economic injury levels and economic threshold (2), Analysis and modeling for pest management and case histories (2), Decision and succession of crop pests as influenced by biotic and abiotic factors (3), Key factor and time series analysis in pest management (3), Pest management in major crops (5), Integration of IPM options in integrated farming systems and sustainable agriculture (3).

**Practical**

Collection and identification of natural enemies of insect pests of rice, pigeon pea, vegetables and oilseeds (2), Calculation of diversity index and economic thresholds (2), Demonstration of IPM technology in field crops (1), Scouting (1), Impact analysis (1), IPM in protected cultivation system (2).

**AE 508 ADVANCED TECHNIQUES OF PLANT PROTECTION 3 (2+1)**

Pest control equipment principles, operation, maintenance, selection (2), Application of pesticides and bio-control agents, seed dressing, soaking, root-dip treatment, dusting, spraying (low and high volume sprayers), Application through irrigation water (6), soil disinfections, soil fumigation (4), sterilization, solarisation, deep ploughing (summer), flooding (stagnant water treatment), Techniques to check the spread of pest through seed, bulbs, corms, cuttings and cut flowers (2), Physical cleaning, cutting and removal of infected parts, hot water treatment, Use of light, Microscopy (3), Use of tissue culture techniques in Plant protection (4), Computer application for predicting/forecasting pest/disease attack and identification (4).

**Practical**

Identification and learning about function of various plant protection equipments and their parts (5), calibration of sprayers (0), seed dressing, soaking, root-dip treatment, dusting, spraying (low and high volume sprayers) (3), Solarization, Microscopy (2).

**AE 509 BIOLOGICAL CONTROL 3 (2+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.

**AE 509 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS 3(2+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.

**AE 511 STORAGE PESTS AND THEIR MANAGEMENT 3(2+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).

### **AE 512 INSECTS OF INDUSTRIAL IMPORTANCE 3 (2+1)**

#### **(Apiculture/ sericulture/Lac culture)**

**Apiculture:** Introduction to apiculture (1), Bee biology, natural enemies and seasonal management (3), Ecology and behaviour of bees (1), Methods of communication and reproduction (2), Bees as pollinator (1), Bee keeping equipments, honey extraction and bee products (2), Beekeeping as industry in India (2).

**Sericulture:** History, development and organization of silk industry (1), food plants of silkworm, the cultivation and management (2), Mulberry and on-mulberry silkworms and their systematic (2), Bio-ecology of mulberry silkworm (1), silkworm rearing technology (2), diseases, predators and parasitoid of silkworms and their management (4).

**Lac culture:** History of lac culture (1), Bionomics of lac insect, natural enemies of lac insect and their management (3), Lac host management (2), Lac production technology (1). Lac processing (1), Bio products of lac industry and their utilization (1), Lac based production (1).

#### **Practical**

Identification of bee species (1), Apicultural equipment (1), Ecology examination, bee activities, seasonal management, colony multiplication, queen rearing, control of bee enemies and diseases, colony records, production/collection, use and testing of bee products (4), Propagation and layout, pruning, harvesting of mulberry (1), Identification of mulberry and non-mulberry silkworms (1), Morphology and anatomy of silkworm (1), rearing of mulberry silkworm (2), Identification of various disease, predators and parasitoid of silkworms (2), Identification of life stages of lac insects (1), care and maintenance of host of lac insect (1), Identification of natural enemies of lac insect (1), visit to production units (1).

**Department of Plant Pathology**  
**Curriculum and Syllabus**

Semester	Course Code & Name	Coarse title	Credit Hrs.	Mid Exam.	Final Exam		Total
					Theory	Practical	
Ist Semester	APP-501	Introductory Mycology	3(2+1)	20	50	30	100
	APP-504	Principles of Plant Pathology	3(3+0)	20	50	30	100
	APP-505	Detection and Diagnosis of Plant Diseases	2(0+2)	20	50	30	100
	AS-501	Agricultural Statistics	3(2+1)	20	50	30	100
	Total		11				

II <sup>nd</sup> Semester	APP-503	Plant Bacteriology	3(2+1)	20	50	30	100
	APP-502	Plant Virology	3(2+1)	20	50	30	100
	*APP-514	Insect Vectors of Plant Viruses and other Pathogens	2(1+1)	20	50	30	100
	*APP-512	Ecology of Soil-Borne Plant Pathogen	3(2+1)	20	50	30	100
	Total		11				

Semester	Course Code & Name	Coarse title	Credit Hrs.	Mid Exam.	Final Exam		Total
					Theory	Practical	
III <sup>rd</sup> Semester	APP-506	Principles of Plant Disease Management	3(2+1)	20	50	30	100
	*APP-507	Diseases of Field and Medicinal Crops	3(2+1)	20	50	30	100
	APP-508	Diseases of Fruits, Plantation and Ornamental Crops	3(2+1)	20	50	30	100
	APP-516	Integrated Disease Management	3(2+1)	20	50	30	100
	CA-502	Computer Application in Agricultural	2(1+1)	20	50	30	100
	Total		14				
IV <sup>th</sup> Semester	*APP-509	Diseases of Vegetable and Spices	2(1+1)	20	50	30	100
	*APP-517	Mushroom Production Technology	3(2+1)	20	50	30	100
		Seminar	1(0+1)				
	Thesis Or Add five courses each of 4 credits as optional papers.		20				
	Total		61				

**Compulsory non-credit courses enlisted in the last part of the syllabus may be taught in association with other running courses.**

## PLANT PATHOLOGY

### Course Contents

#### APP -501 INTRODUCTORY MYCOLOGY 3(2+1)

##### **Objective**

To study the nomenclature, classification and characters of fungi.

##### **Theory**

Introduction, definition of different terms, basic concepts. Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology. Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi. 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 reservation of specimens. Isolation and identification of plant pathogenic fungi.

##### **Suggested Readings**

Ainsworth GC, Sparrow FK & Susman HS. 1973. *The Fungi – An Advanced Treatise*. Vol. IV (A & B). Academic Press, New York.

Alexopoulos CJ, Mims CW & Blackwell M. 2000. *Introductory Mycology*. Ed. John Wiley & Sons, New York.

Mehrotra RS & Armeja KR. 1990. *An Introductory Mycology*. Wiley Eastern, New Delhi.

Singh RS. 1982. *Plant Pathogens – The Fungi*. Oxford & IBH, New Delhi. Webster J. 1980.

#### APP- 502 PLANT VIROLOGY 3(2+1)

##### **Objective**

To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

##### **Theory**

History of plant viruses, composition and structure of viruses. Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship. Virus nomenclature and classification, genome organization, replication and movement of viruses. Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics. Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome. 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 ultratome, PCR.

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**Suggested Readings**

- Bos L. 1964. *Symptoms of Virus Diseases in Plants*. Oxford & IBH., New Delhi.  
Brunt AA, Krabtree K, Dallwitz MJ, Gibbs AJ & Watson L. 1995. *Virus of Plants: Descriptions and Lists from VIDE Database*. CABI, Wallington.  
Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold, London.  
Hull R. 2002. *Mathew's Plant Virology*. 4<sup>th</sup> Ed. Academic Press, New York.

**APP 503 -PLANT BACTERIOLOGY 3(2+1)**

**Objective**

To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

**Theory**

History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria. Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them. Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya. General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria. 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.

**Suggested Readings**

- Goto M. 1990. *Fundamentals of Plant Bacteriology*. Academic Press, New York.  
Jayaraman J & Verma JP. 2002. *Fundamentals of Plant Bacteriology*. Kalyani Publ., Ludhiana.  
Mount MS & Lacy GH. 1982. *Phytopathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.  
Verma JP, Varma A & Kumar D. (Eds). 1995. *Detection of Plant Pathogens and their Management*. Angkor Publ., New Delhi.  
Verma JP. 1998. *The Bacteria*. Malhotra Publ. House, New Delhi.


**APP- 504 PRINCIPLES OF PLANT PATHOLOGY 3(3+0)**


**Objective**

To introduce the subject of Plant Pathology, its concepts and principles.

**Theory**

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection, symptomatology, disease development-

  
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role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens. Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies.

#### **Suggested Readings**

- Agrios GN. 2005. *Plant Pathology*. 5<sup>th</sup> Ed. Academic Press, New York.
- Heitefuss R & Williams PH. 1976. *Physiological Plant Pathology*. Springer Verlag, Berlin, New York.
- Mehrotra RS & Aggarwal A. 2003. *Plant Pathology*. 2<sup>nd</sup> Ed. Oxford & IBH, New Delhi. Singh RS. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH, New Delhi.
- Singh DP & Singh A. 2007. *Disease and Insect Resistance in Plants*. Oxford & IBH, New Delhi.
- Upadhyay RK & Mukherjee KG. 1997. *Toxins in Plant Disease Development and Evolving Biotechnology*. Oxford & IBH, New Delhi.

#### **APP-505 DETECTION AND DIAGNOSIS OF PLANT DISEASES 2(0+2)**

**Objective** To impart training on various methods/ techniques/ instruments used in the study of plant diseases/ pathogens.

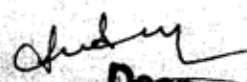
#### **Practical**

Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida. 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.

#### **Suggested Readings**

- Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.
- Fox RTV. 1993. *Principles of Diagnostic Techniques in Plant Pathology*. CABI Wallington.
- Mathews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press, Boca Raton, Tokyo. Pathak VN. 1984. *Laboratory Manual of Plant Pathology*. Oxford & IBH, New Delhi.
- Forster D & Taylor SC. 1998. *Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology*. Humana Press, Totowa, New Jersey.
- Mathews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press, Florida.
- Noordam D. 1973. *Identification of Plant Viruses, Methods and Experiments*. Cent. Agric. Pub. Doc. Wageningen.
- Trigiano RN, Windham MT & Windham AS. 2004. *Plant Pathology-Concepts and Laboratory Exercises*. CRC Press, Florida.
- Chakravarti BP. 2005. *Methods of Bacterial Plant Pathology*. Agrotech, Udaipur.

  
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**APP- 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT 3(2+1)****Objectives**

To acquaint with different strategies for management of plant diseases.

**Theory**

Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management. 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. 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.

**Suggested Readings**

- Fry WE. 1982. *Principles of Plant Disease Management*. Academic Press, New York. Hewitt HG. 1998. *Fungicides in Crop Protection*. CABI, Wallington.  
 Marsh RW. 1972. *Systemic Fungicides*. Longman, New York.  
 Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, New Delhi.  
 Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer-Verlag, New York.  
 Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

**APP-507 DISEASES OF FIELD AND MEDICINAL CROPS 3(2+1)****Objective**

To educate about the nature, prevalence, etiology, factors affecting disease development and control measures of field and medicinal crop diseases.

**Theory**

Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize. Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean. Diseases of Oilseed crops- Rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor. Diseases of Cash crops- cotton, sugarcane. Diseases of Fodder legume crops- berseem, oats, guar, lucerne, cowpea. Medicinal crops- plantago, liquorice, *mulathi*, rosagrass, sacred basil, mentha, *ashwagandha*, *Aloevera*.

**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.

**Suggested Readings**

- Joshi LM, Singh DV & Srivastava KD. 1984. *Problems and Progress of Wheat Pathology in*

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South Asia. Malhotra Publ. House, New Delhi.

Rangaswami G. 1999. *Diseases of Crop Plants in India*. 4<sup>th</sup> Ed.. Prentice Hall of India, New Delhi.

Singh RS. 1998. *Plant Diseases*. 7<sup>th</sup> Ed. Oxford & IBH, New Delhi.

Singh US, Mukhopadhyay AN, Kumar J & Chaube HS. 1992. *Plant Diseases of International Importance*. Vol. I. *Diseases of Cereals and Pulses*. Prentice Hall, Englewood Cliffs, New Jersey.

#### APP-508 DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS 3(2+1)

##### Objective

To acquaint with diseases of fruits, plantation, ornamental plants and their management.

##### Theory

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. Symptoms, mode of perpetuation of diseases of plantation crops such as tea, coffee, rubber and coconut and their management. 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.

##### Suggested Readings

Gupta VK & Sharma SK. 2000. *Diseases of Fruit Crops*. Kalyani Publ., New Delhi. Pathak VN.

1980. *Diseases of Fruit Crops*. Oxford & IBH, New Delhi.

Singh RS. 2000. *Diseases of Fruit Crops*. Oxford & IBH, New Delhi.

Walker JC. 2004. *Diseases of Vegetable Crops*. TTPP, India.

#### APP-509 DISEASES OF VEGETABLE AND SPICES CROPS 3(2+1)

##### Objective

To impart knowledge about symptoms, epidemiology of different diseases of vegetables and spices and their management.

##### Theory

Nature, prevalence, factors affecting disease development of bulb, leafy vegetable, crucifers, cucurbits and solanaceous vegetables. Diseases of protected cultivation. Symptoms and management of diseases of different root, bulb, leafy vegetables, crucifers, cucurbits and solanaceous vegetable crops. Symptoms, epidemiology and management of diseases of different spice crops such as black pepper, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger.

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**Practical**

Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops.

**Suggested Readings**

Chaube HS, Singh US, Mukhopadhyay AN & Kumar J. 1992. *Plant Diseases of International Importance*. Vol. II. *Diseases of Vegetable and Oilseed Crops*. Prentice Hall, Englewood Cliffs, New Jersey.

Gupta VK & Paul YS. 2001. *Diseases of Vegetable Crops*. Kalyani Publ., New Delhi Sherf AF & McNab AA. 1986. *Vegetable Diseases and their Control*. Wiley InterScience, Columbia.

Singh RS. 1999. *Diseases of Vegetable Crops*. Oxford & IBH, New Delhi.

Gupta SK & Thind TS. 2006. *Disease Problem in Vegetable Production*. Scientific Publ., Jodhpur.

Walker JC. 1952. *Diseases of Vegetable Crops*. McGraw-Hill, New York.

**APP 512 ECOLOGY OF SOIL-BORNE PLANT PATHOGENS 3(2+1)****Objective**

To provide knowledge on soil-plant disease relationship.

**Theory**

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. Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis. 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.

**Suggested Readings**

Baker KF & Snyder WC. 1965. *Ecology of Soil-borne Plant Pathogens*. John Wiley, New York.

Cook RJ & Baker KF. 1983. *The Nature and Practice of Biological Control of Plant Pathogens*. APS, St Paul, Minnesota.

Garret SD. 1970. *Pathogenic Root-infecting Fungi*. Cambridge Univ. Press, Cambridge, New York.

Hillocks RJ & Waller JM. 1997. *Soil-borne Diseases of Tropical Crops*. CABI, Wallington.

Parker CA, Rovira AD, Moore KJ & Wong PTN. (Eds). 1983. *Ecology and Management of Soil-borne Plant Pathogens*. APS, St. Paul, Minnesota.

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**APP-514 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS 2(1+1)****Objective**

To teach the students about the different groups of insects that vector plant pathogens, vector-plant pathogen interaction, management of vectors for controlling diseases.

**Theory**

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. Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors. Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips. Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers. 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.

**Suggested Readings**

- Basu AN. 1995. *Bemisia tabaci* (Gennadius) - Crop Pest and Principal Whitefly Vector of Plant Viruses. Oxford & IBH, New Delhi.  
 Harris KF & Maramorosh K. (Eds.). 1980. *Vectors of Plant Pathogens*. Academic Press, London.  
 Maramorosh K & Harris KF. (Eds.). 1979. *Leafhopper Vectors and Plant Disease Agents*. Academic Press, London.

**APP-516 INTEGRATED DISEASE MANAGEMENT 3(2+1)****Objective**

To emphasize the importance and need of IDM in the management of diseases of important crops.

**Theory**


Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications. Development of IDM- basic principles, biological, chemical and cultural disease management. IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed-mustard, pearl millet, *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.

**Suggested Readings**

- Gupta VK & Sharma RC. (Eds.). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.  
 Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.).

  
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2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi.

#### APP-517 MUSHROOM PRODUCTION TECHNOLOGY 3(2+1)

##### Objective

To develop mushroom cultivation skills for entrepreneurial activity. Historical development of mushroom cultivation and present status of mushroom industry in India.

##### Theory

Historical development of mushroom cultivation and present status, taxonomy, classification, food, medicinal value, uses of mushroom, edible and poisonous mushrooms. Life cycle of cultivated mushrooms, reproduction and strain improvement, maintenance of pure culture, preparation of spawn and facilities required for establishing commercial spawn lab. 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. Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO<sub>2</sub>, ventilation in cropping rooms, cultivation technology of *Agaricus bisporus*, *Pleurotus* sp., *Calocybe indica*, *Lentinus edodes* and *Ganoderma lucidum*. 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.

##### Suggested Readings

Chadha KL & Sharma SR. 2001. *Advances in Horticulture (Mushroom)*. Vol. XIII. Malhotra Publ. House, New Delhi.

Chang ST & Hays WA. 1997. *The Biology and Cultivation of Edible Mushrooms*. Academic Press, New York.

Chang ST & Miles PG. 2002. *Edible Mushrooms and their Cultivation*. CRC Press, Florida.

Kapur JN. 1989. *Mushroom Cultivation*. DIPA, ICAR, New Delhi.

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## M.Sc. (Ag.) AGRICULTURAL EXTENSION

I <sup>st</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 511	Development Perspective of Extension Education	3(2+1)	20	30	50	100
EXT 512	Development Communication and Information Management	3(2+1)	20	30	50	100
EXT 513	Diffusion and Adoption of Innovations	3(2+1)	20	30	50	100
AS 501	Agricultural Statistics	3(1+1)	20	30	50	100
	<b>Total Credit</b>	<b>12</b>				
II <sup>nd</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 522	Entrepreneurship Development and Management in Extension	3(2+1)	20	30	50	100
EXT 523	Human Resource Development	3(2+1)	20	30	50	100
EXT 524	Participatory methods for technology Development and transfer	3(2+1)	20	30	50	100
	<b>Total Credit</b>	<b>9</b>				
III <sup>rd</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 521	E-Extension	3(2+1)	20	30	50	100
EXT 531	Research methods in behavioral sciences	3(2+1)	20	30	50	100
EXT 532	Visual Communication	3(2+1)	20	30	50	100
EXT 611	Advances in Agricultural Extension	2(1+1)	20	30	50	100
CA 502	Computer Application in Agriculture	2(1+1)	20	30	50	100
	<b>Total Credit</b>	<b>13</b>				
IV <sup>th</sup> Semester			Evaluation Marks			
Code No.	Course Title	Credit Hours	Mid Term	Practical	Theory	Total
EXT 591	Masters Seminar	1	-	-		100
EXT 599	Masters Thesis Or Add five course each of 4 credits as optional paper	20	-	-	-	100
	<b>Total Credit</b>	<b>21</b>				
	<b>Total Credit Hours</b>	<b>55</b>				

Compulsory non-credit courses enlisted in the last part of the syllabus may be taught in association with other running courses.



### M.Sc. (Ag) Programme

**EXT 511                      Development Perspectives of Extension Education                      3(2+1)**

#### **Objective**

The course is intended to orient the students with the concept of extension education and its importance in Agriculture development and also to expose the students with various rural development programmes aimed at poverty alleviation and to increase employment opportunities and their analysis. Besides, the students will be learning about the new innovations being brought into the Agricultural Extension in India.

#### **Theory**

Extension Education — Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions — Extension Education as a Profession — Adult Education and Distance Education. 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. Poverty Alleviation programmes - SGSY, SGRY, PMGSY, DPAP, DDP, CAPART — Employment Generation Programmes — NREGP, women Development Programmes — ICDS, MSY, RMK, Problems in Rural Development. Current Approaches in extension: Decentralized 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 presentation

#### **Suggested Readings**

- Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS. 2005. Extension Education What? And What Not? RBSA publ.
- Gallagher K. 1999. Farmers Field School (FES) — A Group Extension Process based on Non-Formal Education methods. Global EPM Facility, FAO.
- Gancsan R, Iqbal IM & Anandaraja N. 2003. Reaching the Unreached: Basics of Extension Education. Associated Publishing com.
- Jalihal KA & Veerabhadraiah V. 2007. Fundamentals of Extension Education and Management in Extension. Concept Publ.

- Khan PM 2002. Textbook of Extension Education. Himalaya Publ.  
 Ray GL 2006 Extension Communication and Management. Kalyani Publ.  
 Van Den Ban AW & Hawkins HS. 1998 Agricultural Extension .2nd Ed. CBS.  
 Viswanathan M. 1994. Women in Agriculture and Rural Development. Printwell Publ.

**EXT 512 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**

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. 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. 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 conference, Computer Assisted Instruction, Computer technology and its implications. 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.

**Practical**

Writing News for Farm News paper/Magazines. Reporting of Various Extension activities like-Field day, Training, result Demonstration and farmer' fair etc. Preparing and delivering effective speech. Handling of communication and recording equipments (like-Computer,

P.A. System & Camera). Script writing for Radio, T.V. Conducting students' visit to Radio & T.V. station

### Suggested Readings

- Dahama OP & Bhatnagar OP. 2005. Education and Communication for Development. Oxford & IBH.
- Grover I. Kaushik S, Yadav L & Varna SK. 2002. Communication and Instructional Technology. Agrotech Publ. Academy.
- Jana B1 & Mishra K P. 2005. Farm Journalism. Agrotech Publ. Academy.
- Ray GL 2006. Extension Communication and Management. Kalyani Publ.
- Rayudu CS. 2002. Communication. Himalaya Publ. House.
- Reddy AA. 1987. Extension Education. Sree Lakshmi Press, Bapatla.
- Sandhu A S. 2004. 1 extbook on Agricultural Communication Process and Methods. Oxford & IBH.

**EXT 513**

**Diffusion and Adoption of Innovations**

**3(2+1)**

### Objective

The students will learn how the agricultural innovations spread among the farmers in the society by getting into the insights of diffusion concept and adoption process, stages of adoption and innovation decision process, adopter categories and their characteristics, opinion leaders and their characteristics, attributes of innovations, and factors influencing adoption. In addition, the students would be learning various concepts related to diffusion and adoption of innovations.

### Theory

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. 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. 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. 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.

### Suggested Readings

- Dasgupta 1989. Diffusion of Agricultural Innovations in Village India. Wiley Eastern.  
 Jalihal KA & Veerabliadraiah V. 2007. Fundamentals of Extension Education and Management in Extension. Concept Publ. Co.  
 Ray G L. 2005. Extension Communication and Management. Kalyani Publ.  
 Reddy AA. 1987. Extension Education. Sree Lakshmi Press, Bapatla.  
 Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, New York.

EXT 521

e- Extension

3(2+1)

### Objective

Students will gain knowledge and skills in understanding the concepts of Information and communication technologies and how these ICT tools can be used for Agricultural Extension. Besides, he studies various ICT projects which are successful in delivering the services to the clientele fulfilling the objective of Transfer of technology i.e. Reaching the unreached.

### Theory

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs. advantages, limitations and opportunities. ICTs projects, case studies in India and developing world. Different approaches ( models) to ICTs. ICT use in 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. Community Radio, Web. Tele, and Video conferencing. Computer Aided Extension. knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts. 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

Agri 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.

### Suggested Readings

Batnakar S & Schwarc R. 2000. Information and Communication Technology in Development- Cases from India. Sage Publ.

Meera SN. 2008. ICTs in Agricultural Extension: Tactical to Practical. Ganga-Kaveri Publ. House. JangamWadiMath, Varanasi.

Willem Zip. 1994. Improving the Transfer and Use of Agricultural Information - A Guide to Information Technology. The World Bank, Washington.

**EXT 522 Entrepreneurship Development and Management in Extension 3(2+1)**

### Objective

The first part of the course is intended to provide overall picture of planning and development of enterprises for extending sustainable livelihoods for rural people. The second part of the course is structured to help the students to gain (knowledge and skills in different concepts and techniques of management in extension organizations.

### Theory

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 Intrepreneurs. 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. 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, Making planning effective. 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. Coordination — Concept, Need, type 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 institution-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.

#### **Suggested Readings**

- Gupta CB. 2001. Management Theory and Practice. Sultan Chand & Sons.  
Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.  
Khanka SS. 1999. Entrepreneurial Development. S. Chand & Co.  
Singh D. 1995. Effective Managerial Leadership. Deep & Deep Publ.  
Tripathi PC & Reddy PN. 1991. Principles of Management. Tata McGraw Hill.  
Vasanta Desai 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

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**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**

Human Resource Development — Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, 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; innovation productivity -job description — analysis and evaluation; Performance Appraisal. 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 Skills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics : Leadership styles — Group dynamics. 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 Prospective.

**Practical**

Visit to different training organizations to review ongoing 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.

#### **Suggested Readings**

- Ageohiya D. 2002. Every trainers Handbook. Sage Publ.  
 David Gross 1997 Human Resource management - The Basics. TR Publ.  
 Davis Keth & Newston W John 1989. Human Behaviour at Work. 8th Ed. McGraw-Hill.  
 Hersey Paul & Balanchard H Kenneth. 1992. Management of Organizational Behaviour Utilizing Human Resource. 5<sup>th</sup> edition Prentice-Hall of India.  
 Knoont / Harold Weihrich Heinz 1990. Essentials of Management. 5th Ed. McGraw-Hill.  
 Lynton RP Pareek U. 1993. Training for Development. DB. Taraporewale Sons & Co.  
 Punna Rao P & Sudarshan Reddy M. 2001. Human Resource Development Mechanisms for Extension Organization. kalyani Publ.  
 Rao TV. 2003. Readings in Human Resource Development. Oxford Publ. Co.  
 Silberman Mel. 1995. Active Training. Press Johnston Publ. Co., New Delhi.  
 Singh RP. 2000. management of Training Programmes. Anmol Publ.  
 Subba Rao P. 2005. Management & Organizational Behavior. Himalaya Publ. House.  
 Sundaram R M. Gupta V, George SS. 2006. Case Studies in Human Resource Management. ICFAI, Hyderabad.  
 Tripathi & Reddy. 2004. Principles of Management. Tata McGraw-Hill.  
 Wayne MR Robert MN. 2005. Human Resource Management. International Ed. Pearson Prentice Hall.

**EXT 524 Participatory Methods for Technology Development and Transfer 3(2+1)**

#### **Objective**

This course is intended to orient the students with the key concepts, principles process of different participatory approaches for technology development and transfer and also to expose the students with various participatory tools and techniques like space related, time related, relation oriented methods. Besides the students will be learning the preparation of action plans participatory monitoring and evaluation.

#### **Theory**

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. 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. 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

#### **Suggested Readings**

Adhikary 2006. Participatory Planning and Project Management in Extension Science. Agrotech Publ. Academy.

Mukharjee N. 2002. Participatory Learning and Action. Concept Publ. Co.

Singh BK. 2008. PRA/PLA and Participatory Training. Adhyayan Publ. & Distr.

Somesh Kumar. 2002. Methods for community Participation. Vistaar Publ.

**EXT 531**

**Research Methods In Behavioural Science**

**3(2+1)**

#### **Objective**

This course is designed with a view to provide knowledge and skills in methods of behavioural sciences research and student will learn the appropriate statistics for data analysis.

#### **Theory**

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. 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, type 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. 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. Data processing — Meaning, coding, preparation of master code sheet, analysis and tabulation of data, 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 humiliation 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.- Pretesting of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research. Writing report, Writing of thesis and research articles-Presentation of reports.

### Suggested Readings

- Chandrakandan K, Venkatapirabu J, Sekar V & Anand Kumar V. 2000. Tests and Measurements in Social Research. APH Publ.
- Kerlinger FN. 1973. Foundations of Behavioural Research. Holt Rhinehart.
- Kothari CR. 1984. Research Methodology, Methods and Techniques. Chaitanya Publ. House.
- Krislinaswanii OR & Ranganatham M. 2005. Methodology of Research in Social Sciences. Himalaya Publ. House.
- Mlulay S & Sabaratnam VE. 1983. Research Methods in Extension Education. Manasavan.
- Ranjit Kumar. 1999. Research Methodology - A Step by Step Guide for Beginners. Sage Publ.
- Ray GL & Sagar Mondal. 1999. Research methods in Social Sciences and Extension Education. Naya Prokash.
- Wilkinson TS & Bhandarkar PC. 1993. Methodology and Techniques of Social Research. Himalaya Publ. Home.

EXT 532

Visual Communication


3(2+1)

### Objective

This course is intended to give a clear perspective about the importance of visuals and graphics in communication. The course starts with the delineating about the characteristics of visuals and graphics followed by its main functions, theories of visual perception and its classification and selection. Further, the course deals with the designing the message, graphic formats and devices and presentation of data. It makes the students to understand, prepare and present the scientific data effectively by using low cost visuals. The course also exposes the students to various Video material in multimedia and also enable to design visuals for print, TV and know-how about scanning of visual.

### Theory

Role of visuals & graphics in Communication Characteristics of visuals & graphics. Functions of visuals and Graphic theories of visual, perception classification and selection of visuals. Designing message for visuals, graphic formats and devices. Presentation of scientific data. Principles and production of low cost visuals. Photographs - reprographic visuals. PC based visual. Digitized video material in multimedia production Designing graphic for print and TV and video. Pre-testing and evaluation of visuals.

  
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**Practical**


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 611****Advances in Agricultural Extension****2(1+1)****Theory**

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. Cyber Extension - Concept of cyber extension, national and international cases of extension Projects using ICT and their impact of 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. Stakeholders analysis in Extension. Main streaming gender in Extension - Issues and Prospects. 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. Extension and contemporary issues: Extension and issues-related to rural poverty. Privation 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 Centers.

**Practical**

Analysis of ITK systems, cases on integration of ITK and formal research system, Analysis of cases on cyber extension and privatization of extension. Analyses of ATMA and SREP. Practicing bottom up planning. Visit to —public private Farmer partnership. Learning from Food and Nutritional Security and bio-diversity Projects and programmes.

  
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**Department of Soil Science & Agricultural Chemistry**  
**M.Sc. (Ag.) Semester wise course Distribution**

<b>1st Semester</b>		
Code No.	Course Title	Credit Hrs.
SSAC 504	Soil Mineralogy, Genesis, Classification & survey	3(2+1)
SSAC 509	Soil, water and Air pollution	3(2+1)
SSAC 511	Analytical Techniques & instrumental methods	2(0+2)
AS 501	Agricultural Statistics	3(2+1)
<b>IInd Semester</b>		
SSAC 501	Soil Physics	3(2+1)
SSAC 502	Soil Fertility & Fertilizer Use	4(3+1)
SSAC 506	Soil Biology & Biochemistry	3(2+1)
SSAC 503	Soil Chemistry	3(2+1)
<b>IIIrd Semester</b>		
SSAC 505	Soil erosion and conservation	3(2+1)
SSAC 510	Remote Sensing & GIS Techniques for soil & crop studies	3(2+1)
SSAC 513	Management of Problematic soils & waters	3(2+1)
CA 502	Computer Application in Agriculture	2(1+1)
<b>IVth Semester</b>		
SSAC 591	Masters Seminar	1
SSAC 599	Thesis Or Add five courses each of 4 credits as optional paper.	20 20
	<b>Total Cr. Hrs</b>	<b>56</b>
<b>Compulsory non-credit courses enlisted in the last part of the syllabus may be taught in association with other running courses.</b>		

## SOIL SCIENCE & AGRICULTURAL CHEMISTRY

### Course Contents

SSAC 501

SOIL PHYSICS

3Cr. (2+1)

#### Objective

To impart basic knowledge about soil physical properties and processes in relation to plant growth.

#### 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.

  
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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

### **SSAC 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

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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 <sup>use</sup> 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

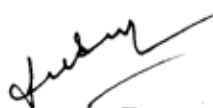
Fertilizer use efficiency; blanket fertilizer recommendations — usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management.

### 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

  
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- Analysis of plants for essential elements

SSAC 503

SOIL CHEMISTRY

3Cr. (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<sub>e</sub>, 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<sub>b</sub> by the use of E<sub>b</sub>-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<sub>4</sub>/E<sub>6</sub>) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the A (E<sub>4</sub>/E<sub>6</sub>) 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<sub>2</sub>-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

### **SSAC 504 SOIL MINERALOGY, GENESIS, CLASSIFICATION 3 Crs. (2+1) AND SURVEY**

#### **Objective**

To acquaint students with basic structure of aluminosilicate 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

SSAC 505

SOIL EROSION AND CONSERVATION

3 Crs. (2+1)

**Objective**

To enable students to understand various types of soil erosion and measures to be taken for controlling soil erosion to conserve soil and water.

**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 (Elm) 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; socioeconomic 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

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- Computation of rainfall erosivity index (EI<sub>30</sub>) using rain gauge data
- Visits to a watersheds

SSAC 506

SOIL BIOLOGY AND BIOCHEMISTRY

3 Crs. (2+1)

**Objective**

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

**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

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- Measurement of important soil microbial processes such as ammonification, nitrification, N<sub>2</sub> fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect

SSAC 509

SOIL, WATER AND AIR POLLUTION

3 Crs. (2+1)

**Objective**

To make the students aware of the problems of soil, water and air pollution associated with use of soils for crop production.

**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.

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### 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

### SSAC 510 REMOTE SENSING AND GIS TECHNIQUES FOR 3 Crs. (2+1) SOIL, WATER AND CROP STUDIES

#### Objective

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remote sensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to krigging, and GIS and applications in agriculture.

#### 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 aerial photographs 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

### **SSAC 511 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 2 Crs. (0+2)**

#### **Objective**

To familiarize the students with commonly used instruments — their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

#### **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 spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractometry; 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.

**SSAC513 MANAGEMENT OF PROBLEM SOILS AND WATERS 3 Crs. (2+1)****Objective**

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

**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.

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**Practical**

- Characterization of acid, acid sulfate, salt-affected and calcareous soils
- Determination of cations ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$ ) in ground water and soil samples
- Determination of anions ( $\text{Cl}^-$ ,  $\text{SO}_4^{--}$ ,  $\text{CO}_3$  and  $\text{HCO}_3$ ) in ground waters and soil samples
- Lime and gypsum requirements of acid and sodic soils

  
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## DEPARTMENT OF SOIL CONSERVATION

Course Code	Course Name	Credit
<b>Ist Semester</b>		
SCW-501	Soils and Soil Conservation	3 (2+1)
SCW-502	Soil and Water Conservation Engineering	3 (2+1)
SCW-503	Conservation Forestry and General Silviculture	3 (2+1)
AS-501	Agricultural Statistics	3 (2+1)
	<b>Total Credit</b>	<b>12</b>
<b>IInd Semester</b>		
SCW-504	Water Management and Conservation Farming	3 (2+1)
SCW-505	Watershed and Water Management	3 (2+1)
SCW-506	Soil Physics in Soil and Water Conservation	3 (2+1)
SCW-507	Rain Water Harvesting and Management	2 (2+0)
	<b>Total Credit</b>	<b>11</b>
<b>IIIrd Semester</b>		
SCW-508	Chemistry of Problem Soils and their Management	3 (2+1)
SCW-509	Conservation Irrigation and Drainage	3 (2+1)
SCW-510	Agroforestry and Agrostology	3 (2+1)
CA-502	Computer Application in Agricultural	2 (1+1)
	<b>Total Credit</b>	<b>11</b>
<b>IVth Semester</b>		
Soils-511	Analytical Techniques and Instrumental Method in Soil and Plant analysis	2 (0+2)
SCW-591	Seminar	1 (0+1)
	Master Thesis Or Add five course each of 4 credits as optional papers	20
	<b>Total Credit</b>	<b>23</b>
<b>Grand Total</b>		<b>57</b>
<b>Compulsory non-credit courses enlisted in the last part of the syllabus may be taught in association with other running courses.</b>		

### SCW-501 SOILS AND SOIL CONSERVATION 3 (2+1)

**Theory:** Modern concept of soil rock and minerals; Weathering of rocks and weathering indices; Factors of soil formation; Soil forming processes; evolution of soil body in nature; Soil profile and concept of soil pedon; Soil classification, U.S. Soil Taxonomy- its advantages and limitations. Soils of India and Uttar Pradesh-their distribution and important physical and chemical characteristics. Soil Survey-Objectives, types of soil survey, land use capability classification. Soil properties in relation to soil erodibility.

**Practical:** Study of soil profile; Preparation of land use capability map. Determination of particle size distribution, organic carbon, pH, Electrical conductivity, available N,P and K in soil. Wet aggregate analysis of soils; Erodibility indices-dispersion ratio and erosion ratio.

### SCW-502 SOILS AND WATER CONSERVATION ENGINEERING 3 (2+1)

**Theory:** Hydrologic processes- Precipitation, infiltration, evaporation, evapo-transpiration, runoff etc. Stream gauging-site selection, measurement of stream stage, measurement of stream discharge, rating curves. Hydrograph-segments, components, factors affecting shape of hydrograph, unit hydrograph. Soil erosion, estimation of soil erosion, effects of erosion on natural resources public work and other economic aspects. Sedimentation- sources, factors affecting sedimentation, sediment sampling measurements and control measures. Planning, design and construction of bonds and terraces. Vegetated waterways and diversion ditches. Gully control-vegetative measures, temporary check dams, permanent structures and their design. Ponds and reservoirs-design and construction. Land clearing, land leveling; estimation of earthwork in land leveling; land development equipments.

**Practical:** Surveying and leveling. Estimation of precipitation, runoff and soil loss. Design and layout of contour bonds, terraces, waterways and diversion ditches. Visit to soil conservation centres and projects.

### SCW-503 CONSERVATION FORESTRY AND GENERAL SILVICULTURE 3 (2+1)

**Theory:** Forestry needs of the country; Extent of forests in India and Uttar Pradesh; Forest policy; Role of forest in national economy; Forest influences- productive, protective and bio-aesthetic. Locality factors; Plant succession; Broad forest types of India and Uttar Pradesh; Natural and artificial regeneration of forest, silvicultural systems; Tending operations; Participatory forest management, Joint forest management. Soil conservation practices to support afforestation of problem-sites-ravines and gullied land, waterlogged areas, saline and alkali soils, steep hill slopes, landslides and slips and stream bank control; shelter belt and wind breaks; Sand dune fixation; Choice of species for different problem site.

**Practical:** Nursery techniques; Soil working techniques; land scape planning; Identification of important tree species; Measurement of height and diameter to assess the plant growth: Silvicultural characteristics of tree species- *Accacia nilotica*, *Accacia catechu*, *Albizia* sp. *Adina cordifolia*, *Azadirachta indica*, *Cassia* sp. *Dalbergia sisso*, *Eucalyptus* sp., *Dandrocalmus strictus*, *Holoptelia integrifolia*, *Populus* sp., *Tectona grandis*, *Leucaena leucocephala*, *Prosopis juliflora*, *Pongamia pinnata*, Visit of Institutes related to Forestry and Soil Conservation.

### **SCW-504 WATER MANAGEMENT & CONSERVATION FARMING 3 (2+1)**

**Theory:** Water management: Water requirement, factors affecting water requirement of crops, water use and water use efficiency; Irrigation scheduling-techniques, irrigation requirement of different crops and quality of water for irrigation; Drainage, Effect of excess moisture on crop and their management in waterlogged areas; Evaporation and Evapo-transpiration, techniques of reducing ET losses and factors affecting ET. Conservation farming: Agronomy in soil conservation, Conservation cropping systems, cover cropping and strip cropping; Advances in dryland Agriculture- Rainfed farming and dryland farming, characteristics of dry land farming, dryland farming practices, water harvesting techniques.

**Practical:** Determination of moisture deficit, available soil moisture, water holding capacity of soil. Determination of moisture extraction pattern. Water requirement of different crops, moisture use and water use efficiency. Measurement of ET in field conditions. Determination of irrigation requirement for different crops.

### **SCW-508 CHEMISTRY OF PROBLEM SOILS AND THEIR MANAGEMENT 3 (2+1)**

**Theory:** Acid and salt affected soils- their origin, distribution, classification, reclamation and management practices; Waterlogged Soils- their classification, changes in soil pH, electrical conductivity, Redox potential and transformation of important plant nutrients during waterlogging, management of waterlogged soils for crop production. Fertility problems of eroded soils and their management; quality of irrigation water and use/of brackish water for crop production.

**Practical:** Determination of gypsum requirement of sodic soils-, preparation of saturation extract of soil and its analysis for cations and anions. Analysis of irrigation waters for their quality appraisal. Determination of hydraulic conductivity, bulk density, particle density and porosity of soils.

### SCW-509 CONSERVATION IRRIGATION AND DRAINAGE 3 (2+1)

**Theory:** Irrigation: Water resources and irrigation development in India. Water conveyance and control- design of open channels, lining of watercourses and field channels, erosion control, water control and diversion structures. Measurement of irrigation water-velocity-area method, water meters, weirs, Parshall flume, orifices etc. Water application methods and their design, comparative efficiency and economics of different methods of irrigation. Tube wells, hydraulics of wells, construction of tube wells, well development, common well troubles Pumps- construction, operation, maintenance, common troubles and remedies of centrifugal pumps, vertical turbine pumps, submersible pumps, propeller and mixed flow pumps, jet pumps, air lift pumps, hydraulic ram. Drainage: Causes of water logging, benefits of drainage, drainage co-efficient, surface drainage methods, design of drainage ditch, sub-surface drainage methods, design of pipe drains. Drainage in relation to salinity control.

**Practical:** Measurement of irrigation water, study of tube wells and pumps, design and layout of irrigation and drainage systems.

### SCW-505 WATERSHED AND WASTELAND MANAGEMENT 3 (2+1)

**Theory: Watershed management:** Concept, need, principles and components of watershed management; Integrated watershed management; Factors affecting watershed management; Runoff and soil loss management in a watershed; Socioeconomic concept of watershed- peoples participation in watershed management. Application of Remote Sensing, GIS and Isotope Technology in survey and problem identification for planning and management watershed. Policy approaches and management plan. Problems of watershed management.

**Wasteland management:** Definition, concept and types of degraded and wasteland. Distribution and extent of watershed in India and Uttar Pradesh; Factors responsible for land degradation; Characteristics of different types of degraded and wasteland; Problems of degraded land in Uttar Pradesh. Appropriate techniques for management of different types of degraded and wasteland.

**Practical:** Preparation of master plan for watershed. Participatory Rural Appraisal (PRA) techniques in watershed. Watershed monitoring and evaluation, Estimation of runoff and soil loss in a Watershed area. A case study of watershed. Visit to model watersheds.

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SCW-508 AGROFORESTRY AND AGROSTOLOGY

3 (2+1)

**Theory:** Agroforestry, concept, need, scope, advantage and limitation of agroforestry; Classification of agroforestry systems; Prevailing agroforestry systems in India and Uttar Pradesh; Edaphic and climatic requirement of multipurpose tree species; Tree crop interaction, nutrient cycling, allelopathy and mycorrhizal inoculation; Non-wood forest product obtained from various agroforestry systems; shifting cultivation, taungya cultivation-, social and farm forestry. Agroforestry research and education in India. Agrostology-definition scope and types of grass covers, Ecological characteristics of important grass species; Grass land and grazing land of Uttar Pradesh and India; Establishment method of grasses; types of grazing; grasses, and legumes for special problem sites, Agronomy of important cultivated grasses.

**Practical:** Nursery and soil working techniques; Numerical problems on nursery size, quantity of seed and monitorial requirement in different soil working/plantation; Idemification of common NFTs, MPTs for agro-forestry; Layout and design of model agroforestry systems. Study of morphological characteristics, Propagation techniques, cover capacity of selected grasses, identification of grasses.

SCW-506 SOIL PHYSICS IN SOIL AND WATER CONSERVATION 3 (2+1)

**Theory:** Soil texture-mechanical analysis, Stoke's 'law. Soil texture in relation to plant growth. Soli structure-classification, genesis and theory of aggregate formation, Pore-size, distribution, soil crust and seedling emergence. Management of highly permeable, slowly permeable and compacted soil. Soil structure and plant growth. Dynamic properties of soils-soil consistency, hydration, swelling, shrinkage, hardening and cracking. Soil tilth and tillage. Soil moisture constants, soil water potential, measurement of soil-water content and potential using conventional and modern techniques. Water flow-Darcy's law, Bernoulli's equation, Poiseuille's law and theories of saturated and unsaturated flow, hydraulic conductivity and diffusivity, and factors affecting it. Infiltration, redistribution and evaporation of soil water. Control of soil water evaporation. Soil water balance and measurement of its components. Solute transport in soil, Soil air-composition, characterization of

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soil aeration status, importance in crops and factors affecting it. Renewal of soil air, Fick's laws of diffusion and soil aeration in relation to plant growth. Sources of soil heat and heat, balance, heat capacity, thermal conductivity and diffusivity of soil. Soil temperature in relation to plant growth.

**Practical:** Determination of mechanical components, field capacity, bulk density particle density, hydraulic conductivity, infiltration ratio, soil aggregates and dispersion ratio. Measurement of soil water.

**SCW-507 RAIN WATER HARVESTING AND MANAGEMENT 2(2+0)**

**Theory:** Problems, characteristics and dynamics of soil productivity in dryland and rainfed areas. Damages caused by soil erosion and strategies for soil conservation. Soil and water conservation techniques in dryland areas-vegetative cover, conservation tillage, mulching, cover crops, alley cropping, vegetative barriers. *In-situ* water conservation and runoff harvesting techniques-tillage, graded border strips, inter plot and inter row water harvesting. Soil and water conservation techniques in difficult sites-ravinous areas, stream bank control, torrent control, land slips and land slides and desert areas.

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Non Credit Course Detail For  
All M.Sc. (Ag)

### 1<sup>st</sup> Semester

PGS-501	Library and Information Services	0+1
PGS-502	Technical writing and Communication	0+1

## 2<sup>nd</sup> Semester

PGS-503 (e-course)	Intellectual Property and its managements in Agriculture	1+0
PGS-504	Basic concept in Laboratory Techniques	0+1

### 3<sup>rd</sup> Semester

PGS 505 (e-course)	Agricultural Research, Research ethics and Rural Development Programme.	1+0
PGS 505 (e-course)	Disaster Management	1+0

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## Course Contents

### PGS 501: LIBRARY AND INFORMATION SERVICES (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, 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; e-resources access methods.

### PGS 502: TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)

#### Objective

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

#### 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, precis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

**Communication Skills** - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

### PGS 503: INTELLECTUAL PROPERTY AND ITS (1+0)

#### (e-Course) MANAGEMENT IN AGRICULTURE

#### Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in knowledge-based economy.

### **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 (0+1)**

#### **Objective**

To acquaint the students about the basics of commonly used techniques in laboratory.

**Practical** Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; 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 (1+0) (e-Course) AND RURAL DEVELOPMENT PROGRAMMES**

#### **Objective**

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

#### **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 District Programme, Special group -Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

**PGS 506: DISASTER MANAGEMENT (1+0)****(e-Course)****Objectives**

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

**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.