BANARAS HINDU UNIVERSITY

INSTITUTE OF AGRICULTURAL SCIENCES

PROSPECTUS OF STUDIES

B.Sc.(Ag.)/M.Sc.(Ag.)/Ph.D.COURSES
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INSTITUTE OF AGRICULTURAL SCIENCES

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ORDINANCES

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

PART I  Admission, Course requirements and Examinations

PART II  Courses and Syllabi

Ordinances Part I : Admission, Course requirements and Examinations

Clause Nos.

1  Ordinances Governing Admission To B.Sc.(Ag.), M.Sc. (Ag.) and Ph.D. courses

   (i)  B.Sc. (Ag.)                   1.0  –  1.7
   (ii) M.Sc. (Ag.)                  2.0  –  2.9
   (iii) Ph.D.                      3.0  –  3.7

2  Ordinance Governing Credit and Course requirements of B.Sc.(Ag.), M.Sc. (Ag.) and Ph.D. courses

   (i)  B.Sc. (Ag.)                  4.0  –  4.2
   (ii) M.Sc. (Ag.)                  5.0  –  5.4
   (iv)  Ph.D.                      6.0  –  6.4

3  Ordinances Governing Evaluation of Course Work

4  Ordinances Governing Special Examinations and Thesis work of M.Sc. (Ag.)

5  Ordinances Governing Special Examinations and Research Work of Ph.D.

6  Ordinances Defining other Terms
### Part – II: Courses and Syllabi

**B.Sc.(Ag.)/M.Sc.(Ag.)/Ph.D. Courses**

**Agricultural Economics**

List of Courses

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<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td></td>
<td>(Theory + Practical)</td>
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<tr>
<td><strong>B.Sc. (Ag.) Courses</strong></td>
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<tr>
<td><strong>Core Courses</strong></td>
<td></td>
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</tr>
<tr>
<td>AEC-121: Principles of Agricultural Economics</td>
<td>2 (2+0)</td>
<td></td>
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<tr>
<td>AEC-211: Agricultural Finance and Co-Operation</td>
<td>2(1+1)</td>
<td></td>
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<tr>
<td>AEC-221: Agricultural Marketing, Trade and Prices</td>
<td>2 (1+1)</td>
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<tr>
<td>AEC-311: Fundamentals of Agri-Business Management</td>
<td>2 (1+1)</td>
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<tr>
<td>AEC-321: Production Economics and Farm Management</td>
<td>2 (1+1)</td>
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| **M.Sc. (Ag.) Courses** |                                                |              |
| **Core Courses** |                                                |              |
| AEC 501* | Micro Economic Theory And Applications | 2(2+0) | |
| AEC 502* | Macro Economics and Policy | 2(2+0) | |
| AEC 503* | Evolution of Economic Thought | 1(1+0) | |
| AEC 504* | Agricultural Production Economics | 2(1+1) | |
| AEC 505* | Agricultural Marketing & Price Analysis | 3(2+1) | |
| AEC 506* | Research Methodology For Social Sciences | 2(1+1) | |
| AEC 507* | Econometrics | 3(2+1) | |
AEC 508*  Linear Programming  2(1+1)
AEC 509*  Agricultural Finance And Project Management  3(2+1)
AEC 510  International Economics  2(1+1)
AEC 511  Agricultural Development And Policies  1(1+0)
AEC 512  Institutional Economics  2(2+0)
AEC 513  Natural Resource And Environmental Economics  2(1+1)
AEC 514  Intellectual Property Management  1(1+0)
AEC 515  Rural Marketing  2(2+0)
AEC 516  Commodity Futures Trading  2(2+0)
AEC517/ABM513#  Computer Applications For Agri-Business & Economics  3(1+2)
AEC 591*  Master’s Course Seminar  1(1+0)
AEC 592*  Master’s Research Seminar  (US/S***)
AEC 599*  Master’s Research  20

Ph.D.

Core Courses

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

Core Courses

AEC-121: Principles of Agricultural Economics  

AEC-211: Agricultural Finance and Co-Operation  
**Practical:** Factors governing use of Capital and identification of credit needs; Time value of money, Compounding and discounting; Tools of financial management, Balance sheet, Income statement and cash flow analysis; Estimations of credit needs and determining unit costs; Preparations and analysis of loan proposals; Types of repayment loans; Study of financial institutions: PACS, DCCB, Apex Banks, RRBs, CBs, NABARD.

**AEC-221: Agricultural Marketing, Trade and Prices**


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

**AEC-311: Fundamentals of Agri-Business Management**

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

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

**AEC-321: Production Economics and Farm Management**


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

**M.Sc. (Ag.) Courses**

**Core Courses**

**AEC 501 MICRO ECONOMIC THEORY AND APPLICATIONS**

**Theory**


**UNIT III** Market Equilibrium - Behavior of Firms in Competitive Markets - Perfect Competition- Effect of
Taxation and Subsidies on market equilibrium - Monopoly- Monopolistic - Oligopoly- Theory of Factor Markets.


AEC 502 MACRO ECONOMICS AND POLICY

Theory
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 IV_IS & LM frame work - General Equilibrium of product and money markets Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy - Central banking.
UNIT V_Business cycles - Balance of Payment - Foreign Exchange Rate determination.

AEC 503 EVOLUTION OF ECONOMIC THOUGHT

Theory
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 IV_The Era of globalization – Experiences of developing world - Rigidity of the past vs. emerging realism – The changing path of international Institutions to economic growth and development approaches.
UNIT V_Economic Thought in India – Naoroji and Gokhale – Gandhian Economics - Economic thought of independent India – Nehru’s economic philosophy - Experiences of the Structural adjustment programmes of the post liberalization era.

AEC 504 AGRICULTURAL PRODUCTION ECONOMICS

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; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement - Nature and sources of risk, modeling and coping strategies.

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

AEC 505 AGRICULTURAL MARKETING AND PRICE ANALYSIS 3(2+1)

Theory


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.


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

AEC 506 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES 2(1+1)

Theory


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.


Practical


AEC 507 ECONOMETRICS 3(2+1)

Theory

UNIT I Introduction – relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis.

UNIT II Basic two variable regression - assumptions estimation and interpretation-approaches to estimation - OLS, MLE and their properties - extensions to multi variable models-multiple regression estimation and interpretation.

UNIT III Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches - model misspecification.

UNIT IV Use of dummy variables-limited dependent variables – specification, estimation and interpretation.
UNIT V  Simultaneous equation models – structural equations - reduced form equations - identification and approaches to estimation.

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

AEC 508 LINEAR PROGRAMMING  
2(1+1)

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

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

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

Theory
UNIT I Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing - Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI’s - NGO’s, and SHG’s.
UNIT II Lending to farmers – The concept of 3 C’s, 7 P’s and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.
work Techniques – PERT and CPM.


Practical


AEC 510 INTERNATIONAL ECONOMICS 2(1+1)

Theory

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

Practical


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

Theory

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


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

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

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

AEC 512 INSTITUTIONAL ECONOMICS

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

AEC 513 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS

Theory


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

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


Practical

AEC 514 INTELLECTUAL PROPERTY MANAGEMENT 1(1+0)

Theory

UNIT II Discovery versus Invention - Patentability of Biological Inventions - Method of Agriculture and Horticulture- procedure for patent protection: Preparatory work. Record keeping, writing a patent document, filing the patent document -Types of patent application-patent application under the Patent cooperation treaty (PCT).
UNIT IV Trademark- Geographical Indications of Goods and Commodities – Copy rights-Designs – Biodiversity Protection.
UNIT V Procedures for commercialization of technology - Valuation, Costs and Pricing of Technology- Licensing and implementation of Intellectual Properties- Procedures for commercialization – Exclusive and non exclusive marketing rights-Research Exemption and benefit sharing.

AEC 515 RURAL MARKETING 2(2+0)

Theory

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

AEC 516 COMMODITY FUTURE TRADING 2(2+0)

Theory

UNIT I History and Evolution of commodity markets – Terms and concepts: spot, forward and futures Markets –
factors influencing spot and future markets. Speculatory mechanism in commodity futures.

UNIT II  Transaction and settlement – delivery mechanism - role of different agents - trading strategies -potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets. UNIT III  Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features. UNIT IV  Important global and Indian commodity exchanges - contracts traded – special features - Regulation of Indian commodity exchanges - FMC and its role.

UNIT V  Fundamental Vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.

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

Contents

UNITII
Input-Output Devices, Storage Units (Disks, CD-ROM, DVD-ROM, Blue Ray Disk and tapes), Memory Types (Cache, RAM, ROM), Memory Units, Generation and types of Microprocessor.

UNITIII
Data and Information – Data Definition, Data Processing Systems, Data Type Numeric, Alphabetic, Audio, Graphic, and Video and Their Presentation; Data Processing- Introduction to Data Processing, Computer as a Tool For Data Processing, Data Processing Cycle, Data Processing Techniques, Data Analysis, Data Inputs and Outputs, Data Processing Management, , Data Security.

UNIT IV  Introduction to Operating Systems, MS Windows, and UNIX, MS Office (MS Word, MS Power Point, MS Excel, MS-Access and use of various management software’s Like SPSS. UNIT IV  Introduction to LAN, WAN, MAN, internet and search engines; Introduction to agri-portals like agriwatch.com, agmarknet.nic.in, echaupal.com

Practical: Operation of various systems and software e.g. MS Windows, and UNIX, MS Office (MS Word, MS Power Point, MS Excel, MS-Access and use of various management software’s Like SPSS. Data Processing and analysis. Network setting and practical utility of networking in agricultural economics.
Ph.D. COURSES

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

Theory


UNIT II  Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models – collusive and non-collusive models of oligopoly - Cournot model, Chamberlin model, Stackleberg solution.


Practical


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

Theory


AEC 603 ADVANCED ECONOMETRICS 3(2+1)

Theory

UNIT III Dummy variables - Qualitative and truncated dependent variables - limited dependent variables – LPM, probit and logit models, their multinomial extensions.
UNIT IV Autoregressive distributed lag models – panel data fixed and random effects models and their extensions.
UNIT V Simultaneous equation methods – identification – estimation by indirect least squares 2SLS, PIML, SURE, 3SLS.

Practical


AEC 604 ADVANCED PRODUCTION ECONOMICS 3(2+1)

Theory

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


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

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

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

Practical

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

AEC 605 QUANTITATIVE DEVELOPMENT POLICY ANALYSIS 2(1+1)

Theory


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

UNIT III Household behaviour and policy analysis – Household models.


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

Practical


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

**Theory**

**UNIT I** Importance of market analysis in the agricultural system - types of marketing-advantages and disadvantages - quantitative estimation -the distinguishing characteristics and role of agricultural prices -data sources for agricultural products and prices - softwares used in market analysis.

**UNIT II** Role of various formal institutions in agricultural marketing - and functions - measuring their efficiency - public - private partnership - institutional arrangements. Successful case studies.


**UNIT IV** Agricultural commodity marketing - spot and futures- marketing of derivatives-speculation, hedging, swap, arbitrage etc. commodity exchanges - price discovery and risk management in commodity markets- Regulatory mechanism of futures trading.

**UNIT V** Lag operators and difference equations; stationary and stochastic processes; UNIT roots and cointegration; conditional heteroscedasticity: ARCH and GARCH models -forecast evaluation; methods of forecasting. price indices and econometric estimation and simulation.

**Practical**

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

**AEC 607 NATURAL RESOURCE MANAGEMENT**  2(1+1)

**Theory**

**UNIT I** Natural resources - definition - characteristics and classification. Stock dynamics of renewable and non-renewable resources. Equation of motion for renewable and non-renewable resources. Fundamental equation of renewable resources.

**UNIT II** Growth curves of fishery and forest resources. The role of time preference in natural resource use. Simple two-period model of optimal use of renewable and non-renewable resources. Advanced models of optimal resource use – Static Vs. dynamic efficiency in natural resource use Applications of dynamic programming and optimal control.

**UNIT III** Economics of groundwater use - optimal extraction of groundwater. Analytical and numerical solutions for optimal inter-temporal allocation of natural resources. Optimal harvesting of single rotation and multiple rotation forests. Optimal management of fishery. **UNIT IV** Property rights in natural resources and their implication for conservation and management of natural resources. Management of common property natural resources – Institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource.
UNIT V Resource scarcity – Natural resource degradation – Poverty and resource degradation – Natural resource accounting - Pricing and valuation of natural resources – Natural resources policy.

Practical


AEC 608 ENVIRONMENTAL ECONOMICS 3(2+1)

Theory

UNIT II Environmental cost benefit analysis - Environmental impact assessment techniques
Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.
UNIT IV Environment, ecology and environmental accounting - Environmental pollution with respect to water and air - Land and forest resources related environmental pollution - Coastal externalities - Urbanization and environment - Basic approaches to environmental policy (Tax, subsidy, pollution permits etc.) Green taxes - Political economy of environmental regulation and management.
UNIT V Transboundary environmental problems - Economics of global warming, climate change and emission trading - Environment, international trade and development.

Practical

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

## List of Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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### B.Sc. (Ag.) Courses

#### Core Courses

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<tr>
<td>AGR-111</td>
<td>Principles of Agronomy and Agricultural Meteorology</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>AGR-112</td>
<td>Introductory Agriculture (Ancient Heritage, Agricultural Scenario and Gender Equity in Agriculture)</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>AGR-121</td>
<td>Water Management</td>
<td>3(2+1)</td>
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<tr>
<td>AGR-211</td>
<td>Weed Management</td>
<td>3(2+1)</td>
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<tr>
<td>AGR-212</td>
<td>Organic Farming</td>
<td>2(1+1)</td>
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<tr>
<td>AGR-312</td>
<td>Field Crops - I (<em>Kharif</em>)</td>
<td>3(2+1)</td>
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<tr>
<td>AGR-321</td>
<td>Field Crops - II (<em>Rabi</em>)</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>AGR-322</td>
<td>Farming Systems and Sustainable Agriculture</td>
<td>2(1+1)</td>
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### M.Sc. (Ag.)

#### Core Courses

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<tr>
<td>AGR 501*</td>
<td>Modern Concepts in Crop Production</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>AGR 502*</td>
<td>Principles and Practices of Soil Fertility and Nutrient Management*</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>AGR 503*</td>
<td>Principles and Practices of Weed Management</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>AGR 504*</td>
<td>Principles and Practices of Water Management</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>AGR 505</td>
<td>Agro meteorology and Crop Weather Forecasting</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>AGR 506</td>
<td>Agronomy of Major Cereals and Pulses</td>
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<td>AGR 507</td>
<td>Agronomy of Oilseed, Fibre and Sugar Crops</td>
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<td>AGR 508</td>
<td>Agronomy of Medicinal, Aromatic and Under Utilized Crops</td>
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<td>Agronomy of Fodder and Forage Crops</td>
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<td>AGR 510</td>
<td>Agrostology and Agroforestry</td>
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<td>AGR 511</td>
<td>Cropping Systems</td>
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<td>AGR 512</td>
<td>Dryland Farming</td>
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<td>AGR 513</td>
<td>Principles and Practices of Organic Farming</td>
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<td>AGR 514</td>
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<td>AGR 515</td>
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<td>AGR 599</td>
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**Ph.D. COURSES**

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<td>Crop Production and System Modeling</td>
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<td>Advances in Crop Growth and Productivity</td>
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<td>AGR 605</td>
<td>Irrigation Management</td>
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<td>AGR 606</td>
<td>Advances in Weed Management</td>
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<td>AGR 607</td>
<td>Integrated Farming Systems</td>
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<td>AGR 608</td>
<td>Soil Conservation and Watershed Management</td>
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<td>Stress Crop Production</td>
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B.Sc. (Ag.) Courses

Core Courses

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

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

Practical

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

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

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

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

Water management: definition and scope; irrigation: definition and objectives, water resources and irrigation development in India; soil moisture measurement; soil moisture constants; water and irrigation requirement, irrigation scheduling, irrigation water measurement; irrigation methods: surface, subsurface, sprinkler and drip irrigation; irrigation efficiency and water use efficiency; irrigation water quality and its management; water management of different crops (rice, wheat, maize, pulses, oilseeds, sugarcane, potato, fodder and forages); Drainage: definition, importance, types, and management; management of eroded lands
Practical

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

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

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

Practical

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

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

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

Practical

Aerobic and anaerobic method of making compost and vermicompost making; preparation of enriched farm and industrial based compost; efficient use of biofertilizers- technique of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum and PSB cultures in fields; visit to an organic farm- bio dynamic farm; quality standards, inspection, certification and labelling and accreditation procedures for farm organic produce.
AGR-312: Field Crops - I (Kharif) 3(2+1)

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

**Practical**

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

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

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

**Practical**

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

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

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

**Practical**

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

Core Courses

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

Theory

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

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

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

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

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

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

Theory

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

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

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

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

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

Practical
- Calculation of fertilizer use indices
- Determination of total N, P, K and S in plants
- Interpretation of interaction effects and computation of economic and yield optima
- Calculation of fertilizer use indices

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

Theory

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

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

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

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

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

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

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

**Theory**

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

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

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

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

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

**Practical**
- Measurement of soil water potential by using tensiometer, and pressure plate membrane apparatus
- Soil-flow characteristics curves
- Water flow measurements using different devices
- Determination of irrigation requirements
- Calculation of irrigation efficiency
• Determination of infiltration rate
• Determination of saturated/ unsaturated hydraulic conductivity

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

Theory

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

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

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

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

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

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

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

Theory

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

UNIT II
Kharif cereals – Rice, Maize, Sorghum, Pearl millet, Minor Millets

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

UNIT IV
Kharif pulses – Pigeonpea, Greengram, Blackgram.

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

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

Theory
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of:
UNIT I
Kharif oilseeds – Groundnut, Sesame, Castor, Sunflower, Soybean etc.

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

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

UNIT IV
Sugar crops – Sugar- beet and Sugarcane.

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

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

Theory

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

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

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

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

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

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

Theory

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

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

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

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

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

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

Theory

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

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

UNIT III
Agroforestry: definition and importance; agroforestry systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aquasilviculture, alley cropping and energy plantation.

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

Practical
- Preparation of charts and maps of India showing different types of pastures and agro-forestry systems
- Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry
- Seed treatment for better germination of farm vegetation
- Methods of propagation/planting of grass and trees in silvipastoral system
- Fertilization application in strip and silvipastoral systems
• After-care of plantation
• Estimation of protein content in lopping of important fodder trees
• Estimation of calorie value of wood of important fuel trees
• Estimation of total biomass and fuel wood
• Economics of agro-forestry
• Visit to important agro-forestry research stations

AGR 511 Cropping Systems 2(2+0)

Theory

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

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

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

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

AGR 512 Dryland Farming 3(2+1)

Theory

UNIT I
Definition, concept characteristics of dry land and rainfed farming, significance and dimensions of dry land farming in Indian agriculture.
UNIT II
Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry areas; characterization of environment of water availability.

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

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

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

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

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

Theory

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

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

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

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

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

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

**AGR 514 Field Experimentation**

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

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

UNIT III
Concepts of confounding, complete and partial.

UNIT IV
Interactions and their significance, production functions and their analyses.
**Practical**
Layout of different designs in the field. Numericals, calculations; graphical representations of production functions. Field sampling and its analyses.

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

**Theory**

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

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

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

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

**Practical**
- Characterization of salt-affected, calcareous, acid and waterlogged soils.
- Determination of soil pH, EC, CEC,
- Determination of anions (Cl⁻, SO₄²⁻, CO₃⁻ and HCO₃⁻) in soil.
- Determination of cations (Na⁺, K⁺, Ca²⁺ and Mg²⁺) in soil.
- Lime and gypsum requirements of acid and sodic soils.
Visit to problematic areas to acquaint with production contraints.
Ph.D. Courses

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

Theory

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

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

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

UNIT IV
Precision farming; Climate change, GM crops

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

AGR 602 Crop Ecology 2(2+0)

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

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

UNIT III
Physiological response of crop plants to light, temperature, CO₂, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.
UNIT IV
Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

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

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

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

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

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

UNIT IV
Potential production: leaf and canopy CO₂ assimilation, respiration, dry matter accumulation, crop phonology and dry matter distribution and development in different crops.

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

Practical
- Simulation of elementary models for crop growth
- Simulation of potential production
- Simulation with limitations of water and nutrient management options
- Sensitivity analysis using different climatic years and crop management practices
AGR 604   Advances in Crop Growth and Productivity 3(2+1)

Theory

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

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

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

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

Practical
- Field measurement of root-shoot relationship in crops at different growth stages
- Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc.; at different stages of crop growth
- Computation of harvest index of various crops
- Assessment of crop yield on the basis of yield attributing characters
- Construction of crop growth curves based on growth analysis data
- Computation of competition functions, viz, LER, IER aggressivity competition index etc in intercropping
- Senescence and abscission indices
- Analysis of productivity trend in un-irrigated areas
- Analysis of productivity trend in irrigated areas
UNIT I
Water resources of India, irrigation project; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

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

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

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

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

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

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

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

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

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

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

UNIT V
Herbicide development & registration procedures.

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

AGR 607 Intergrated Farming System 2(2+0)

Theory

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

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

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

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

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

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

Theory

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

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

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

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

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

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

**AGR 609 Streses Crop Production**

**Theory**

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

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

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

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

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

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

**UNIT VII**
Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.
UNIT VIII
Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

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

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<tr>
<td>AHD-221</td>
<td>Livestock production &amp; Management</td>
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<tr>
<td>AHD-311</td>
<td>Introductory Dairy Sciences :</td>
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M. Sc (Ag.) and Ph.D. IN LIVESTOCK PRODUCTION AND MANAGEMENT COURSE

M. Sc (Ag.) LPM COURSES

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<tr>
<td>LPM 601</td>
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<td>SWINE PRODUCTION AND MANAGEMENT</td>
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<td>LPM 604</td>
<td>LABORATORY ANIMAL PRODUCTION AND MANAGEMENT</td>
<td>2(1+1)</td>
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<td>LPM605</td>
<td>SHELTER MANAGEMENT</td>
<td>2(1+1)</td>
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<td>LPM 606</td>
<td>PRINCIPLES OF ENVIRONMENTAL HYGIENE AND WASTE MANAGEMENT</td>
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<tr>
<td>LPM 607</td>
<td>CLIMATOLOGY AND ANIMAL PRODUCTION</td>
<td>1(1+0)</td>
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<tr>
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<td>POULTRY FARM AND HATCHERY MANAGEMENT</td>
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<td>FARM ANIMAL BEHAVIOR</td>
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<td>INTEGRATED LIVESTOCK FARMING SYSTEM</td>
<td>3(2+1)</td>
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LPM 612  WILD LIFE MANAGEMENT AND CONSERVATION 2(2+0)
LPM 613  LIVESTOCK BUSINESS MANAGEMENT 2(1+1)
LPM 691  MASTER’S SEMINAR 1(1+0)
LPM 699  MASTER’S RESEARCH 20

**Ph.D. LPM COURSES**

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

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

**M. Sc (Ag.) DAIRY TECHNOLOGY**

DT 511  ADVANCED DAIRY PROCESSING 4(3+1)
DT 512*  ADVANCED FOOD PROCESSING 4(3+1)
DT 513  RHEOLOGY OF DAIRY AND FOOD PRODUCTS 3(2+1)
DT 514  DAIRY PROCESS BIOTECHNOLOGY 3(2+1)
DT 515  TRADITIONAL AND VALUE-ADDED DAIRY PRODUCTS   3(2+1)
DT 521  MEMBRANE TECHNOLOGY IN DAIRY PROCESSING       3(2+1)
DT 522  ADVANCED DAIRY AND FOOD PACKAGING          3(2+1)
DT 523  ALTERNATIVE PROCESSES FOR THE DAIRY & FOOD INDUSTRIES   3(2+1)
DT 524  FUNCTIONAL FOODS AND NEW PRODUCT DEVELOPMENT  4(3+1)
DT 525  TECHNOLOGY OF FOOD EMULSIONS, FOAMS & GELS      3(2+1)
DT 591  MASTER’S SEMINAR                             1(1+0)
DT 599  MASTER’S RESEARCH                             20

Ph.D. DAIRY TECHNOLOGY

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

B.Sc. (Ag.) Courses

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

Practicals:

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

Practicals:

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

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

Theory

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

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

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

**Theory**

UNIT I

Introduction - Population structure and importance- Advantages and disadvantages of sheep farming under different systems of management – type of housing and equipments- Important sheep and goat breeds- Advantages and disadvantages of sheep and goat farming.
UNIT II
Breeding Management: Breeding seasons - fitness of purchase for first breeding - methods of detection of heat - Natural Service and artificial insemination - Care of the pregnant Animals - Breeding stock - Use of teaser - Culling.

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

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

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

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

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

Theory

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

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

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

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

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

Theory

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

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

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

UNIT IV
Transportation of Laboratory animals – marketing of meat and fur.
Practical

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

LPM 605 Shelter Management 2(1+1)

Theory

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

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

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

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

Practical

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

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

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

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

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

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

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

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

Theory

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

UNIT II
Light, natural and artificial light-mechanism of light action-photo period and light responses – Applications - Importance of light in production of animals and birds.
UNIT III
Introduction of breeds into different climatic regions - Agro meteorology and weather forecasting for Animal Husbandry activities - Micro climate modification in animal houses.

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

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

Theory

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

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

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

UNIT IV
Embryonic development and factors effecting fertility and hatchability of eggs.

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

Practical

Poultry Farm management - Brooding of chicks; selection of laying flocks - Disease preventive measures - Selection and care of hatching eggs; incubator operation, fumigation and candling setting and hatching, packaging of chicks - Waste management - Marketing of products.
LPM 609  Farm Animal Behaviour         1(1+0)

Theory

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

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

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

UNIT IV

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

Theory

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

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

UNIT III
New approach for changing farming systems in present energy crises.

UNIT IV
Project formulation and evaluation of various livestock enterprises.

**Practical**

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

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**LPM 611 EQUINE PRODUCTION AND MANAGEMENT**

**Theory**

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

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

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

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

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

**UNIT VI**

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


**LPM 612 Wild Life Management and Conservation**  
**Theory**

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

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

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

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

**LPM 613 Livestock Business Management**  
**Theory**
UNIT I
Management principles - Planning - Techniques, strategic planning, organization structure, co-ordination and controlling techniques – Approaches to management.

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

UNIT III

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

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

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

Theory

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

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

UNIT III

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

UNIT V

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

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

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

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

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

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

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

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

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

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

UNIT III
Advances in feeding and nutrition in pigs; automatic feeding and watering techniques, Feed stuffs, Energy, protein, minerals and vitamin sources, metabolic and nutritional disorders – Toxic substances.
UNIT IV
Advances in housing of pigs, environmental physiology - Infectious diseases and parasitism. reduction in new born piglet mortality.

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

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

Theory

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

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

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

UNIT IV
Transportation of Laboratory animals – marketing of meat and fur.

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

Practical
Visit to Rabbit farms - Study of the various chores in government farms and private farms - Critical analysis of breeding, feeding, disease control management and housing - Rabbit slaughter technique.
LPM 705  Advances in Poultry Production Management  3(2+1)

Theory

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

UNIT II
Demand, supply, present status of poultry production.

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

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

Practical

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

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

Theory

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

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

UNIT III
Fixing standards in relation to CO₂ - Air supply in relation to cubic space, temperature, air, velocity, relative humidity, dust particles, bacterial count, effective temperature and cooling power - Methods to get over pollution – Cleaning and washing - Air conditioning.
UNIT IV

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

Practical

Assessment of various factors in Indoor and outdoor environment - Assessment of CO₂, air supply, dust particles and bacterial count in air - Visit to sewage treatment plant - Planning farm waste disposals - Physical chemical and bacteriological examination of water watering of farm animals.

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

Theory

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

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

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

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

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

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

DT 511  Advanced Dairy Processing  4(3+1)

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

Water activity; sorption behaviour of foods, energy of binding water, control of water activity of different milk products in relation to their chemical; microbiological and textural properties; hurdle technology and its application in development of shelf-stable and intermediate-moisture foods, Use of carbonation in extending the shelf life of dairy products.
UNIT VI Current trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio-detergents, development of sanitizers- heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

Practical

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

DT 512 Advanced Food Processing 4(3+1)

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Application of heat energy to foods for preservation and processing, concept of drying rate of foods, industrial drying processes of foods; changes during drying, advanced drying processes (Freeze drying, infra red drying and...
microwave drying), Canning of fruits & vegetables, unit processes involved in canning, types of cans for thermal processing of foods.

UNIT V

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

UNIT VII

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

UNIT VIII

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

UNIT IX

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

UNIT X

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

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

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

Theory

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

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

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

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

UNIT V
Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.
UNIT VI
Rheological and textural properties of selected dairy products: Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data.

Practical

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

DT 514 DAIRY PROCESS BIOTECHNOLOGY 3(2+1)

Theory

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

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

UNIT 3
Technological requirements of modified micro-organisms for production of cheese and fermented milk products; technological innovations in the development of functional dairy foods with improved nutritional therapeutic and pro-biotic attributes; physiologically active bio-peptides/ nutraceuticals; protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, pro-biotic cheese and fermented milks; bifidus factors in infant food formulations.

UNIT IV
Protein hydrolysates-production, their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages.
UNIT V
Microbial polysaccharides their properties and applications in foods, production of alcoholic beverages and industrial products from starch; whey and other by-products; bio-sweeteners-types properties and their applications in dairy and food industry.

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

Practical

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

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

Theory

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

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

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

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

UNIT V
Techno-economic aspects for establishing commercial units for traditional products.
UNIT VI
Convenience traditional dairy products; use of natural and permitted synthetic preservatives and new packaging systems.

Practical

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

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

Theory

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

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

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

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

UNIT V
Practical

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

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

Theory

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

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

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

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

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

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

UNIT VII
Retort pouch technology, microwavable, biodegradable, and edible packages.
UNIT VIII
Industrial packaging: unitizing, palletizing, containerising, distribution systems for packaged foods including prevention of shock damage to articles during transportation.

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

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

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

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

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

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

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

UNIT V
Ultrasonic treatment of food: Mechanism of ultrasound induced cell damage, generation of ultrasound equipment, design of power ultrasonic system, types of ultrasonic reactors, application of power ultrasound in food processing.
effects on food constituents, ultrasound in consideration with other process alternatives - thermosonication, advantages and future prospects.

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

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

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

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

Theory

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

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

UNIT III
Food fortification, techniques for fortifying dairy foods with minerals and vitamins, High protein foods prospective nutraceuticals for fortification of dairy foods. Nutritional significance of dietary fibers, classes of dietary fibers, fortification techniques for fibers in dairy foods.
UNIT IV
Infant nutrition and dietary formulations for meeting normal and special needs of infants, current status of infant foods, additives for infant foods. Foods for aged persons, design consideration, ingredients for geriatric foods.

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

UNIT VI

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

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

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

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

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

Practical
Determination of total fiber, neutral detergent fiber in foods; manufacture of fiber enriched milk beverage; manufacture of low calorie burfi/ice cream; preparation of flavoured milk using artificial sweetener and its estimation; determination of antioxidant activity of food/food components; determination of bioavailability of
nutrients; development of malted milk food and weaning food; determination of β-galactosidase activity and application of lactases for lactose free dairy products determination of prebiotic potential of certain plant/milk components and their application in synbiotics dairy foods preparation of sports beverage, herbal dairy drinks; preparation of high protein products.

**DT 525 Technology of Food Emulsions, Foams and Gels**  

**Theory**

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

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

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

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

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

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

**Practical**

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

**DT 611 Advances in Lipid Technology**  

**Theory**

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

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

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

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

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

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

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

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

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

UNIT X
Advances in technologies for production of plasticisers, emulsifiers and protective coatings.
DT 612  Advances in Protein Technology  3(3+0)

Theory

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

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

UNIT III

UNIT IV

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

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

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

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

Theory

UNIT I

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

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

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

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

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

UNIT VII
Monitoring of Food Structure: (b) Elucidation of crystal characteristics of milk fat in ghee and other fat-rich products by means of X-ray Crystallography with reference to the impact of cooling and storage/handling conditions on the crystal nature and product texture; Process-induced changes in sub-microscopic particulate properties of milk products; structure-texture relationship.
UNIT VIII
Monitoring of Food Structure: (c) Influence of heat processing and freezing treatments on protein denaturation and other conformational as well as aggregation-disaggregation phenomena as monitored through Spectropolarimetry, Circular Dichroism and related techniques.

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

UNIT X

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

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

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

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

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

Theory

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

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

UNIT III

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

UNIT V
Project proposal writing for research funding, Development of feasibility and technical report for dairy plant establishment, evaluation and report writing of projects.
## ENTOMOLOGY & AGRIL. ZOOLOGY

### List of Courses

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### B.Sc. (Ag.) Courses

#### Core Courses

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<td>EAZ – 211</td>
<td>Insect Morphology and Systematics</td>
<td>3(2+1)</td>
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<tr>
<td>EAZ – 221</td>
<td>Insect Ecology and Integrated Pest Management Including Beneficial Insects</td>
<td>3(2+1)</td>
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<tr>
<td>EAZ – 311</td>
<td>Crop Pests and Stored Grain Pests and Their Management</td>
<td>3(2+1)</td>
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<tr>
<td>EAZ – 312</td>
<td>Introductory Nematology</td>
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### M.Sc. (Ag.)

#### Non Credit Compulsory Courses

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<tr>
<td>PGS 501</td>
<td>LIBRARY AND INFORMATION SERVICES</td>
<td>1(0+1)</td>
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<tr>
<td>PGS 502</td>
<td>TECHNICAL WRITING AND COMMUNICATIONS SKILLS</td>
<td>1(0+1)</td>
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<tr>
<td>PGS 503</td>
<td>INTELLECTUAL PROPERTY AND THEIR APPLICATION IN AGRICULTURE (e-Course)</td>
<td>1(1+0)</td>
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<tr>
<td>PGS 504</td>
<td>BASIC CONCEPTS IN LABORATORY TECHNIQUES</td>
<td>1(0+1)</td>
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<tr>
<td>PGS 505</td>
<td>AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (e-Course)</td>
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<tr>
<td>PGS 506</td>
<td>DISASTER MANAGEMENT</td>
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Course Structure

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

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<tr>
<th>Course Code</th>
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<tr>
<td>ENT 601</td>
<td>ADVANCED INSECT SYSTEMATICS</td>
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<tr>
<td>ENT 602</td>
<td>IMMATURE STAGES OF INSECTS</td>
<td>2(1+1)</td>
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<td>ENT 603</td>
<td>ADVANCED INSECT PHYSIOLOGY</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>ENT 604</td>
<td>ADVANCED INSECT ECOLOGY</td>
<td>2(1+1)</td>
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<tr>
<td>ENT 605</td>
<td>INSECT BEHAVIOUR</td>
<td>2(1+1)</td>
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<tr>
<td>ENT 606</td>
<td>RECENT TRENDS IN BIOLOGICAL CONTROL</td>
<td>2(1+1)</td>
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<tr>
<td>ENT 607</td>
<td>ADVANCED INSECTICIDE TOXICOLOGY</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>ENT 608</td>
<td>ADVANCED HOST PLANT RESISTANCE</td>
<td>2(1+1)</td>
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<tr>
<td>ENT 609</td>
<td>ADVANCED ACAROLOGY</td>
<td>2(1+1)</td>
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<tr>
<td>ENT 610</td>
<td>AGRICULTURAL ORNITHOLOGY</td>
<td>2(1+1)</td>
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<td>ENT 611**</td>
<td>MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH</td>
<td>2(1+1)</td>
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<tr>
<td>ENT 612**</td>
<td>ADVANCED INTEGRATED PEST MANAGEMENT</td>
<td>2(2+0)</td>
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<tr>
<td>ENT 613/</td>
<td>PLANT BIOSECURITY AND BIOSAFETY</td>
<td>2(2+0)</td>
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<tr>
<td>PL PATH 606/ENT 691</td>
<td>DOCTORAL SEMINAR - I</td>
<td>1(1+0)</td>
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<tr>
<td>ENT 692</td>
<td>DOCTORAL SEMINAR - II</td>
<td>1(1+0)</td>
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<tr>
<td>ENT 699</td>
<td>DOCTORAL RESEARCH</td>
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## B.Sc. (Ag.) Courses
EAZ – 211. Insect Morphology and Systematics  


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

EAZ – 221 Insect Ecology and Integrated Pest Management Including Beneficial Insects  

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

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

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

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

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

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


Practical: Methods of survey – sampling methods, collection of soil and plant samples; Extraction of nematodes from soil and plant tissues following combined Cobb’s decanting – sieving and Baermann funnel technique, counting and estimation of plant parasitic nematodes; Preparation of temporary and permanent mounts; Method of preparation of perineal patterns for identification of species of *Meloidogyne*; Study and identification of most important plant parasitic nematodes with special
reference to their characteristics and symptomolgy – *Meloidogyne, Pratylenchus, Heterodera, Ditylenchus, Globodera, Tylenchulus, Xiphinema, Radopholus, Rotylenchulus*, and *Helicotylenchus*. Experimental techniques used in pathogenicity studies with root knot nematode.

### M.Sc. (Ag.) Courses

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>PGS -501</td>
<td>Library and Information Services</td>
<td>1(0+1)</td>
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**Objective**

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

**Practical**

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

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<tr>
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<tr>
<td>PGS -502</td>
<td>Technical Writing and Communications Skills</td>
<td>1(0+1)</td>
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**Practical**

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


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

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

**Theory**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers’ rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives;

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

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

**Practical**

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

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

**Theory**
UNIT- I

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

UNIT- II

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

UNIT- III

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

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

Theory

UNIT -I

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

UNIT -II

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

UNIT -III

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

Core Courses
ENT 501  Insect Morphology  2(1+1)

Theory

UNIT- I

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

UNIT -II

Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites.

UNIT -III

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

UNIT- IV

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

Practical

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

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

Theory

UNIT- I

Scope and importance of insect anatomy and physiology.

UNIT -II

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

UNIT- III

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

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

Practical

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

**ENT 503  Principles of Taxonomy  2(2+0)**

**Theory**

UNIT- I

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

UNIT- II

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

UNIT- III


**ENT 504  Classification of Insects  3(2+1)**

**Theory**

UNIT- I

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

UNIT- II
UNIT -III

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

Practical


ENT 505 Insect Ecology 2(1+1)

Objective

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

Theory

UNIT -I


UNIT -II

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

UNIT -III


UNIT- IV


Practical

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

ENT 506   Insect Pathology          2(1+1)

Theory

UNIT- I

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

UNIT- II

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

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

**Practical**


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

**Theory**

UNIT -I

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

UNIT -II

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

UNIT -III

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

UNIT - IV

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

**Practical**

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

**ENT 508 Toxicology of Insecticides 3(2+1)**

**Theory**
UNIT I
Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

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

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

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

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

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

ENT 509 Plant Resistance to Insects 2(1+1)
Theory
UNIT-I
History and importance of resistance, principles, classification, components, types and mechanisms of resistance.

UNIT -II
Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.
UNIT III
Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

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

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

UNIT VI
Role of biotechnology in plant resistance to insects.

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

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

Theory
UNIT I
History and origin, definition and evolution of various related terminologies.

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

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

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

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

Theory

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

UNIT- I

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

UNIT -II

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

UNIT -III

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

Practical

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

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

Theory

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

UNIT- I

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

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

UNIT- III

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

UNIT- IV

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

Practical

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

ENT 513 Storage Entomology 2(1+1)

Theory

UNIT- I

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

UNIT- II

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

UNIT- III

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

UNIT- IV

Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control-
prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

**Practical**

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

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

**Theory**

**UNIT -I**

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

**UNIT -II**

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

**UNIT -III**

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

**UNIT -IV**

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

**UNIT - V**

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

**Practical**

Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies.
ENT 515 General Acarology 2(1+1)

Theory

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

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

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

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

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

Theory

UNIT - I
Soil arthropods and their classification, habitats and their identification.

UNIT -II
Estimation of populations; sampling and extraction methods.

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

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

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

**ENT 517  Vertebrate Pest Management 2(1+1)**

**Theory**

UNIT -I

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

UNIT -II

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

UNIT -III

Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites), cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods- Operational practices- baiting, bioassays (LD50 studies), equipments and educative programmes.

**Practical**

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

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

**Theory**

UNIT -I

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

UNIT -II

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

Use of light, transmission and scanning electron microscopy.

UNIT- IV

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

UNIT -V

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

ENT 519  Commercial Entomology  2(1+1)

Theory

UNIT -I


UNIT -II

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

UNIT -III

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

UNIT -IV


Practical

Assessing pest status in dwellings (labs, canteen or hostel), implementation of pest control against flies, mosquitoes, bed bugs, cockroaches and rodents. Pre- and post-construction termite proofing methods, control of silverfishes in the library. Visit to poultry units and assessing pest status in poultries. Evaluation of commercially available domestic insect pest control products through bioassays. Identification of honey bee species, bee castes and special adaptations, identification and handling of bee-
keeping equipments. Handling of honey bees-hive and frame inspection. Honey extraction and processing methods of hive products extraction. Preparation of bee-keeping projects for funding. Visit to bee nursery and commercial apiaries. Silkworm rearing and management. Lac host and crop management technology and processing of lac. Products and bye-products of lac.

ENT 520  

**Objective**

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

**Theory**

**UNIT -I**

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

**UNIT -II**


**UNIT -III**

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

**UNIT -IV**

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

**Ph.D. Courses**

ENT 601  

**Advanced Insect Systematics**

**Theory**
UNIT -I


UNIT -II


UNIT -III

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

UNIT -IV

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

Practical

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

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

Theory

UNIT -I

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

UNIT -II

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

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

**ENT 603 Advanced Insect Physiology 2(2+0)**

**Theory**

UNIT -I

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

UNIT -II

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

UNIT -III

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

UNIT - IV

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

**ENT 604 Advanced Insect Ecology 2(1+1)**

**Theory**

UNIT -I


UNIT -II


UNIT -III


UNIT- IV

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

Practical


ENT 605   Insect Behaviour          2(1+1)

Theory

UNIT- I

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

UNIT- II

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

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

UNIT - IV

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

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

Practical

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

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

Theory

UNIT -I

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

UNIT - II

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

UNIT -III

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

UNIT - IV

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.
Practical
Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol agents, performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

ENT 607  Advanced Insecticide Toxicology  3(2+1)

Theory
UNIT -I
Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

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

UNIT -III
Joint action of insecticides; activation, synergism and potentiation.

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

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

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

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

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

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

UNIT -III

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

UNIT -IV

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

Practical

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

ENT 609   Advanced Acarology  2(1+1)

Theory

UNIT- I


UNIT- II

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

UNIT- III

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

UNIT -IV

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

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

ENT 610 Agricultural Ornithology 2(1+1)

Theory

UNIT -I

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

UNIT- II


Practical

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

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

Theory

UNIT- I

Introduction to molecular biology; techniques used in molecular biology.

UNIT- II

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

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

UNIT IV

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

UNIT V

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

Practical

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

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

Theory

UNIT -I

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

UNIT -II

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

UNIT -III

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

UNIT-IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.
PL PATH-606

Theory

UNIT-I

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

UNIT- II

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

UNIT- III

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

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II. Master’s Seminar and Research
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Ph.D. Courses
EXT 601  Advances In Agricultural Extension  
EXT 602  Advanced Designs And Techniques In Social Science Research  
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EXT 691  Doctoral Seminar-I  
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B.Sc. (Ag.) Courses
EXT-121  Dimensions of Agricultural Extension  
Education–Meaning, Definition, Types – Formal, Informal and Non-formal education and their}
Characteristics. Extension Education and Agricultural Extension–Meaning, Definition, Concepts,

PRACTICAL
Visits to a village and to study the ongoing development programmes. Visits to Panchayat Raj Institutions to study the functioning of Gram Panchayat (GP) & Zilla Parishad (ZP). Visit and study of the District Rural Development Agency (DRDA). Participation in monthly workshops of Training and Visit (T & V) System. Visit to Watershed Development Project area. Visit to a village to study the Self Help Groups (SHGs. Visit to a voluntary organization to study the developmental activities. Organizing PRA techniques in a village to identify the agricultural problems.
EXT-211 Fundamentals of Rural Sociology and Educational Psychology

EXT-311 Entrepreneurship Development and Communication Skill 2 (1+1)


Communication skill, meaning and process of communication, verbal and non-verbal communication, listening and note taking. Writing skills, oral presentation skills; field diary and lab record, indexing footnote and bibliographic procedures. Reading and comprehension of general and technical articles; summarizing, abstracting; individual and group presentations; public speaking; group discussion. Organizing seminars and conferences.

PRACTICAL

Listening and note taking writing skills, oral presentation skills, field diary and lab record; indexing footnote and bibliographic procedures; reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations.

EXT-322 Extension Methodologies For Transfer of Agricultural Technology 2 (1+1)


PRACTICAL
M.Sc. (Ag.) Courses

EXT 501 Development Perspectives of Extension Education 2(1+1)

Theory
UNIT I
Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.

UNIT II
Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University.

UNIT III

UNIT IV
Current Approaches in Extension: Decentralised Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centres, NAIP.

Practical
Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

EXT 502 Development Communication and Information Management 3(2+1)

Objective
In this course, students will learn about the concept, meaning and process of communication and various methods and modern media of communication. Besides, the students will also learn the information management and journalistic writing of various information materials and also study their readability.

Theory
UNIT I
Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills – fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.
UNIT II
Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development.

UNIT III
Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media – Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.

UNIT IV
Agricultural Journalism as a means of mass communication, Its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

EXT 503  Diffusion and Adoption of Innovations  3(2+1)

Theory
UNIT I
Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice.

UNIT II
The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation.

UNIT III
Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.

UNIT IV
Diffusion effect and concept of over adoption, opinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.
Practical
Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

EXT 504 Research Methods in Behavioural Science 3(2 + 1)

Theory
UNIT I
UNIT II
Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual framework development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximincon Principle, Sampling – Types of sampling and sampling procedures.
UNIT III
Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre –
testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in conducting, advantages and limitations in its use. Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations in its use.

UNIT IV
Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.

Practical
Selection and formulation of research problem - Formulation of objectives and hypothesis-Selection of variables based on objectives-Developing the conceptual framework of research. Operationally defining the selected variables-Development of data collection devices.-Testing the validity and reliability of the data collection instruments.- Pre-testing of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, hands on experiences on SPSS, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research.Writing report, Writing of thesis and research articles-Presentation of reports.

EXT 505 E- Extension 3(2+1)

Theory
UNIT I
ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities.

UNIT II
ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in the field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III

UNIT IV

Practical

**EXT 506  Entrepreneurship Development and Management in Extension  3(2+1)**

**Theory**

**UNIT I**


**UNIT II**


**UNIT III**


**UNIT IV**


Practical
Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs, Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions-Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

EXT 507 Human Resource Development (HRD) 3(2+1)
Objective
To orient the students about key concepts, importance, scope & conceptual framework, growth & development of Human Resource Development, Subsystems of Human Resource Development for extension organization and process of HRD.

Theory
UNIT I
Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual framework, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction, Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment; Motivation productivity – job description – analysis and evaluation; Performance Appraisal.
UNIT II
Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning,
Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Skills required for Extension workers; Decision Making:
Decision Making models, Management by Objectives; Behavioural Dynamics: Leadership styles – Group dynamics.

UNIT III
Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation; Facilities for training – Trainers training – techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospectives.

Practical
Visit to different training organizations to review on going activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers, Studies on evaluation of training programmes; Study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and Human resource information, Presentation of reports.

EXT 508 Visual Communication 3(2+1)
Theory
UNIT I

UNIT II
Designing message for visuals, Graphic formats and devices. Presentation of Scientific data. Principles and production of low cost visuals.

UNIT III
Photographs- reprographic visuals. PC based visuals. Degitized video material in multimedia production. Designing visuals for print and TV and video.

UNIT IV
Pre-testing and evaluation of visuals. Scanning of visuals.

Practicals

EXT 509 Participatory Methods for Technology Development and Transfer 2(1+1)
Theory
UNIT I
Participatory extension – Importance, key features, principles and process of participatory approaches; Different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, ESRE, FPR) and successful models.
UNIT II
Participatory tools and techniques. Space Related Methods: village map (social & resource), mobility services and opportunities map and transect; Time related methods: time line, trend analysis, seasonal diagram. Daily activity schedule, dream map; Relation oriented methods: cause and effect diagram (problem tree), impact – diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis.

UNIT III
Preparation of action plans, concept and action plan preparation; Participatory technology development and dissemination; Participatory planning and management, phases and steps in planning and implementation aspects; Process monitoring, participatory evaluation.

Practical
Simulated exercises on space related methods, time related method and relation oriented methods; Documentation of PTD and dissemination; Preparation of action plan; Participatory monitoring and evaluation of developmental programmes.

EXT 510 Gender Sensitization for Development 3(2+1)

Objective
In this course the students will learn about an overview of the concept of gender and gender balance on development and develop skills of identifying gender roles, rights, responsibilities and relationships on development. Besides the students will also learn the attitudinal change to internalize gender equity concerns as fundamental human rights and also enhance the capability for identifying and analyzing gender issues in agriculture and allied sectors.

Theory
UNIT I
Gender concepts, issues and challenges in development; Gender roles, gender balance, status, need and scope; Gender analysis tools and techniques.

UNIT II
National policy for empowerment of women since independence; Developmental programmes for women; Gender mainstreaming in agriculture and allied sectors –need and relevance; Gender budgeting – A tool for empowering women.

UNIT III
Women empowerment –Dimensions; Women empowerment through SHGapproach; Women entrepreneurship and its role in economic development; Public Private Partnership for the economic empowerment of women; Building rural institution for women empowerment; Women human rights ; Action plans for gender mainstreaming.

Practical
Visits to rural institutions of women for studying in the rural institutions engaged in Women empowerment; Visits to entrepreneurial unit of women for studying the ways and means of establishing entrepreneurship units.
for Women and their development and also SWOT analysis of the Unit; Visit to Center for women development - NIRD to study the different activities related to projects and research on gender; Visit to gender cell, Office of the Commissioner and Director of Agriculture, Hyderabad, to study the mainstreaming of gender concerns and gender budget of the department.

**EXT 511 Perspectives of Distance Education**

**Objective**

The course is intended to orient the students with the concept of Distance Education, Characteristics of Distance Education, Evolution, Methods of Distance Education, Different Approaches in Planning Distance Education, Educational Technology in Distance Education, Management of Resources for distance education, Strategies for maximizing the reach and programme evaluation and quality assessment.

**Theory**

UNIT I
Distance Education – Introduction Meaning, Concept, Philosophy and its work ethics, characteristics of Distance Education – Evolution and Historical view of Distance Education – Theory Methodology, and Epistemology. Dimensions of Distance Education, Scope and difficulties. Open Education – Non-formal Education, Continuing Education, Education by correspondence.

UNIT II
Forms and systems of Distance and Open Education, Modes of Teaching and Learning in Distance Education, Methods of Distance Education, Significance of Distance Education in Teacher Education.

UNIT III
Planning Distance Education – A Systems Approach Student Learning – Course Planning, The target groups – Barriers to learning in Distance Education – Planning and Management of Networked Learning.

UNIT IV
Educational Technology in Distance Education Application of information and Educational Technologies in Distance Education, Development of Course and Course material, Management of resources, processes, Forms of Instructional material in Distance Education and Media Development and Production in Distance Education - Video Classroom Strategy in Distance Education – Strategies for maximizing the reach – services to students, programme Evaluation – performance indicators and Quality Assessment.

**Practical**

Visit to the University which is implementing the Distance Education Programmes. Detailed Study of their programme in relation to Educational Technology, Methodology, Curriculum Development, Evaluation and Assessment. Exercise on development of curriculum for Distance Education exclusively for farming community.

**EXT 512 Market Led Extension**

**Theory**
UNIT I
Agricultural extension at cross roads; Changing scenario of agricultural extension at the national level; Market led extension – emerging perspectives; Market led extension – issues and challenges; Dimensions of market led extension.

UNIT II
Agricultural marketing an overview; Development of a marketing plan, pricing concepts and pricing strategy; Consumer behaviour; Marketing communication and promotional strategies; The marketing research process; Agricultural trade liberalization and its impact; International marketing opportunities; Implications of AOA, TRIPS and IPRs agreements on agriculture; Agreement on SPS and TBT - an over view; Commodity features marketing.

UNIT III
Public private linkages in market led extension; Role of SHG in market led extension; Contact farming – a viable approach to meet market challenges; IT enabled approaches for market led extension and communication; Weather service and crop modeling – An effective tool in market led extension.

Practical
Identification and analysis of different marketing sources for agricultural commodities. Development of strategy for an effective market intelligence system; Development of suitable marketing plan to suite rural situation; Visit to APEDA, Rythu Bazaars to study the processes and procedures related to market-led extension.

Ph.D. Courses

EXT 601       Advances in Agricultural Extension          3(2+1)

Theory
UNIT I
Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

UNIT II
Cyber Extension - Concept of cyber extension, national and international cases of extension projects using ICT and their impact on agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research - Extension -Farmer - Market linkage: Importance, Scope, Implications etc., Market - Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm

UNIT III
Implications of WTO - AOA for extension services, re-orientation of extension services for agri-business and marketing activities, GOI-NGO collaboration to improve efficiency of extension.

UNIT IV

Practical

Analysis of ITK systems, cases on integration of ITK and formal research system, Analysis of cases on cyber extension and privatization of extension. Analysis of ATMA and SREP. Practicing bottom up planning. Visit to Public-Private -Farmer partnership. Learnings from Food and Nutritional Security and bio-diversity Projects and Programmes.

EXT 602  Advanced Designs and Techniques in Social Science Research 3(2+1)

Theory

UNIT I
Scaling technique - meaning, types, principles, steps and quality, techniques of attitude scale construction - Paired comparison, Equal appearing intervals, Successive Intervals, Summated ratings, Scalogram analysis, Scale discrimination technique, Reliability and Validity of Scales. Sociometrics, content analysis, case studies, Q-sort techniques, Semantic differential technique.

UNIT II

Practical

Practice in constructing a scale and use of scale in various situations. Reliability and validity of the scales developed, Application of Semi Projective and Projective techniques. Content analysis, case studies. Practicing participatory tools and techniques. Hands on experience on Computer Preparation and Data Collection instruments, review of previous studies.
EXT 603  Advances in Training Technology  3(2+1)
Theory
UNIT I
Paradigm shift in training - learning scenario, Training Approaches - Experiential learning - laboratory - organization development (system) approaches; Training Design, Designing an effective training programme, Harmonizing training needs, Course Objective, content and methods.
UNIT II
Designing an effective training session - the semantics involved, Designing experiential training sessions, simulation exercises, and openness in training transaction - managing dilemmas, ambivalence and conflicts and confusion (for both trainers and trainees).
UNIT III
Recent Training Techniques for understanding and facilitation team building, group dynamics, motivation and empowerment, laboratory methods: micro-lab process work, and sensitivity training, Psychological instruments as training tools: TAT, Inventories, Cases, etc.
UNIT IV
Participatory Training Techniques - Lecture, Brainstorming, Group discussion and Training Games. Role Play, Psycho-drama, Coaching, Counseling, etc., Trainer’s roles and dilemmas, Factors Effecting Training Effectiveness and Training Evaluation.
Practical

EXT 604  Organizational Development  3(2+1)
Theory
UNIT I
Introduction to organizations: Concept and Characteristics of organizations, Organizational Behaviour - Context and concept - levels of organizations - formal and informal organizations, Theories of organizations: Nature of organizational theory - classical theories - features of Bureaucracy - administrative theory and Scientific management - Neo-classical theories - the human relations movement - modern theory.
UNIT II
Systems approach to study organization needs and motives - Attitude, values and ethical behaviour - alienation and work - work motivation - communication and interpersonal behaviour - organization communication - leadership behaviour - decision making, problem solving techniques - organizational climate - change
proneness and resistance to change, Organizational change, Organizational structure - Process in organizing - Dimension of Motivation Climate.

UNIT III
Departmentation - Span of Management - Delegation of authority - Centralization and decentralization - line and staff organization - functional organization - divisionalisation - Project organization - Matrix organization - free form organization - top management structure.

UNIT IV

Practical

EXT 605 Advanced Instructional Technology 3(2+1)

Objective
By the end of the course student will be able to Understand Agricultural Education Scenario in the country and Curriculum development process, Plan & Prepare and present course outline, Lesson Plan & Skill plan, Develop appropriate Teaching & Learning Styles, Use innovative instructional aids & methods

Theory
UNIT I

UNIT II

UNIT III

Practical

**EXT 606 Theory Constructions In Social Sciences**

**2(2+0)**

**Theory**

**UNIT I**

**UNIT II**

**EXT 607 Advanced Management Techniques**

**3(2+1)**

**Theory**

**UNIT I**
Management Information System (MIS): Basic concepts, types of information needed at various levels, design of MIS in an agricultural extension organization. Scope for computerization, system alternatives and Evaluation. Implementation, operation and maintenance of the MIS system.

**UNIT II**

**UNIT III**

**UNIT IV**
Decision Support Systems (DSSs): Basic information about Artificial Intelligence (AI) Expert System (ESs), their future applications in extension system. Forecasting techniques - time series analysis and Delphi, decision making and talent management PERT, CPM Techniques and time management.
Practical
Managements Information system, in research & development organizations. Study of Management by Objective in an organization. Transactional Analysis, exercises on Team building process, coping skills with organizational stress, exercises on Decision Support Systems (DSSs). Practical exercise on forecasting techniques, Visit to Management organizations.

EXT 608 Media Management 3(2+1)

Theory
UNIT I

UNIT II

UNIT III
UNIT IV

Practical
Exercise on Writing for Print Media – Writing News / Success Stories / Feature articles for different topics related to Agriculture & allied fields. Exercise of editing & proof reading the Farm News for News papers – different types of intro and leads. Exercise of Writing for Radio, TV, Preparation of story board for farm Video Production – Script writing for Radio and T.V. Visit to media management organizations for studying the principles, procedures and processes in managing the media. Participation and Interaction through video conference. Developing communication & Media Strategy for selected developmental programme / activity.

EXT 609 Transfer of Technology in Agriculture 3(2+1)

Theory
UNIT I
Technology - Meaning and Concepts - Appropriate technology, transfer of technology - meaning and concepts. Systems of transfer of technology - Knowledge Generating System (KGS) - Knowledge Disseminating System (KDS) - Knowledge Consuming System (KCS) - Input Supplying Agencies System (ISAS).

UNIT II
Appropriateness of communication media in the system of technology transfer. New communication strategy for transfer and adoption of Agricultural technology. Extension training in transfer of technology.

UNIT III
Analysis. Constraints in Transfer of Technology, agencies or departments involved in TOT. Extension professional in TOT. Attributes of Technology and its Relation in TOT process. TOT to resource poor farmers. Role of Key communicators or local leaders in TOT. Private and Public partnership in TOT.

Practical
Analysis of Transferred technology. Analysis of knowledge generation and consuming systems. Formulation of communication strategies, Study of attributes of selected fast spreading technologies and slow technologies, study of constraints in TOT, visit to TOT centres of ICAR and SAU, Identification of key communicators, Case studies of Public-Private Partnerships, Visits to the print and electronic media centres to study their role in TOT.
# FARM ENGINEERING

## List of Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>B.Sc. (Ag.) Courses</strong></td>
<td></td>
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<tr>
<td></td>
<td><strong>Core Courses</strong></td>
<td></td>
</tr>
<tr>
<td>ENGG-111</td>
<td>Fundamentals of Soil and Water Conservation Engineering</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>STAT-121</td>
<td>Statistics</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>COMP-121</td>
<td>Introduction to Computer Applications</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>ENGG-211</td>
<td>Farm Power and Machinery</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>ENGG-221</td>
<td>Protected Cultivation and Post Harvest Technology</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>ENGG-321</td>
<td>Renewable Energy</td>
<td>2 (1+1)</td>
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<tr>
<td></td>
<td><strong>M.Sc. (Ag.) Courses</strong></td>
<td></td>
</tr>
<tr>
<td>STAT 501</td>
<td>STATISTICAL METHODS FOR APPLIED SCIENCES</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 502</td>
<td>EXPERIMENTAL DESIGNS</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 511</td>
<td>MATHEMATICAL METHODS FOR APPLIED SCIENCES</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>STAT 512</td>
<td>NON PARAMETRIC AND MULTIVARIATE ANALYSIS</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 601</td>
<td>SAMPLING TECHNIQUES</td>
<td>3(2+1)</td>
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<tr>
<td></td>
<td><strong>NOTE:</strong></td>
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<tr>
<td></td>
<td>1. STAT-501 course is compulsory for all M.Sc. students.</td>
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</tr>
<tr>
<td></td>
<td>2. There is no M.Sc. (Agricultural Statistics) programme in the department.</td>
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</tr>
</tbody>
</table>
1. Ph.D. Courses in Agricultural Statistics

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT-601</td>
<td>SAMPLING TECHNIQUES</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 602</td>
<td>ADVANCED STATISTICAL COMPUTING</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 603</td>
<td>SIMULATION TECHNIQUES</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 611</td>
<td>ADVANCED STATISTICAL METHODS</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 612</td>
<td>ADVANCED STATISTICAL INFERENCE</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 613</td>
<td>ADVANCED DESIGN OF EXPERIMENTS</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 614</td>
<td>ADVANCED SAMPLING TECHNIQUES</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 616</td>
<td>STATISTICAL MODELING</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 617</td>
<td>ADVANCED TIME SERIES ANALYSIS</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 618</td>
<td>STOCHASTIC PROCESSES</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 619</td>
<td>SURVIVAL ANALYSIS</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>STAT 651</td>
<td>RECENT ADVANCES IN THE FIELD OF SPECIALIZATION</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>STAT 691</td>
<td>DOCTORAL SEMINAR I</td>
<td>1(1+0)</td>
</tr>
<tr>
<td>STAT 692</td>
<td>DOCTORAL SEMINAR II</td>
<td>1(1+0)</td>
</tr>
<tr>
<td>STAT 699</td>
<td>DOCTORAL RESEARCH</td>
<td>45(45+0)</td>
</tr>
</tbody>
</table>

NOTE:
1. STAT 601 and STAT 602 are supporting courses. These are compulsory for all the students of Agricultural Statistics.
2. STAT 691, STAT 692, STAT 651 and STAT 699 are compulsory for all the students of Agricultural Statistics.
3. A student has to take a minimum of 18 credits course work, excluding the supporting courses, seminar and research. A student has to take two seminars.

2. Ph.D. Courses in Agricultural Engineering (Soil & Water Conservation Engineering)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>SWE 601*</td>
<td>ADVANCED HYDROLOGY</td>
<td>3+0</td>
</tr>
<tr>
<td>SWE 602*</td>
<td>SOIL AND WATER SYSTEMS’ SIMULATION AND MODELLING</td>
<td>2+1</td>
</tr>
</tbody>
</table>

Page No. 138
SWE 603 MOODELLING SOIL EROSION PROCESSES  2+1
SWE 604 ADVANCED HYDRO-MECHANICS IN SOIL AQUIFER SYSTEMS  3+0
SWE 605 HYDRO-CHEMICAL MODELLING AND POLLUTANT MANAGEMENT  3+0
SWE 606 PLANT GROWTH MODELLING AND SIMULATION  3+0
SWE 607 ADVANCES IN IRRIGATION AND DRAINAGE  2+0
SWE 608 REMOTE SENSING TECHNIQUES FOR NATURAL RESOURCES  2+1
SWE 609 WATER RESOURCES PLANNING AND MANAGEMENT  2+1
SWE 691 DOCTORAL SEMINAR I  1+0
SWE 692 DOCTORAL SEMINAR II  1+0
SWE 693 SPECIAL PROBLEM  0+1
SWE 694 CASE STUDY  0+1
SWE 699 DOCTORAL RESEARCH  45

* Compulsory for Doctoral programme

3. Ph.D. Courses in Agricultural Engineering (Bio Process and Food Engineering)

BPFE-601 : ADVANCE AGRICULTURAL PROCESSING FOR VALUE ADDITION  3 (2+1)
BPFE-602 : RHEOLOGY, CHEMISTRY, & PHYSICS OF BIOLOGICAL MATERIALS  3 (2+1)
BPFE-603 : ADVANCE FOOD ENGINEERING AND TECHNOLOGY  3 (2+1)
BPFE-604 : ADVANCES IN GRAIN DRYING  3 (2+1)
BPFE-605 : STORAGE TECHNOLOGY FOR AGRICULTURAL PRODUCE  3 (2+1)
BPFE-606 : PRODUCT PROCESSING OF HORTICULTURAL AND PLANTATION CROPS  3 (2+1)
BPFE-607 : EQUIPMENT AND PROCESS FOR CONFECTIONARY AND CONVENIENCE FOOD  3 (2+1)
ENGG-111: Fundamentals of Soil and Water Conservation Engineering 3 (2+1)


Practical: Acquaintance with chain survey equipment; Ranging and measurement of offsets; Chain triangulation; Cross staff survey; Plotting of chain triangulation, Plotting of cross staff survey; Levelling equipment – dumpy level, levelling staff, temporary adjustments and staff reading; Differential leveling; Profile leveling; Study of centrifugal pumping system and irrigation water measuring devices; Study of different components of drip and sprinkler irrigation systems; Uniformity of water application in drip and sprinkler systems; Study of soil and water conservation measures.

STAT-121: Statistics 2 (1+1)

Introduction: Definition of Statistics and its use and limitations; Frequency Distribution, diagrams and Frequency Curves; Measures of Central Tendency: Characteristics of Ideal Average, Arithmetic Mean; Geometric Mean, Harmonic Mean; Median, Mode, Merits and Demerits of Measures of central tendency; Measures of Dispersion: Standard Deviation, Variance and Coefficient of Variation; Probability: Definition and concept of probability; Test of Significance - Types of Errors, Null Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis; Large ONE Sample Test - SND test for Mean, Single Sample; Small Sample Test for Mean, Student’s t-test for single Sample, Correlation: Types of
Correlation and identification through Scatter Diagram, Computation of Correlation Coefficient ‘r’. Linear Regression: of Y on X and X on Y. The regression coefficients, fitting of regression equations.

**Practical:** Construction of Frequency Distribution Tables and Frequency Curves; Computation of Arithmetic Mean, Geometric Mean, Harmonic Mean for Un-Grouped and Grouped data; Computation of Median for Un-Grouped and Grouped data; Computation of Mode for Un-Grouped and Grouped data; Computation of Standard Deviation, Variance and Coefficient of Variation for Un-Grouped and Grouped data; SND test for Mean, Single Sample, Student’s t-test for Single Sample; Computation for Correlation Coefficient ‘r’; Fitting of regression equations-Y on X and X on Y.

**COMP-121: Introduction to Computer Applications**


**Practical:** Study of Computer Components; Booting of Computer and its Shut Down; Practice of some fundamental DOS commands, TIME, DATE, DIR, COPY, FORMAT, VOL, LABEL, PATH; Practicing WINDOWS Operating System, Use of Mouse, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars; WINDOWS Explorer, Creating Folders, COPY and PASTE functions; MSWORD: Creating a Document, Saving and Editing; MSWORD, Use of options from Tool Bars, Format, Insert and Tools (Spelling and Grammar) Alignment of text; MSWORD, Creating a Table, Merging
of Cells, Column and Row width; MSEXCEL: Creating a Spreadsheet, Alignment of rows, columns and cells using Format
tool bar; MSEXCEL: Entering Expressions through the formula tool bar and use of inbuilt functions, SUM, AVERAGE,
STDEV; MSEXCEL: Data Analysis using inbuilt Tool Packs, Correlation and Regression; MSEXCEL: Creating Graphs and
Saving with and without data; MSACCESS: Creating Database, Structuring with different types of fields; MS Power Point:
Preparation of slides on Power Point; Transforming the data of WORD, EXCEL and ACCESS to other formats; Internet
Browsing: Browsing a Web Page and Creating of E-mail ID.

ENGG-211: Farm Power and Machinery

Farm power– Farm power in India: sources, I.C. engines, working principles of two stroke and four stroke engines, I.C.
gine terminology, Cooling and Lubrication of I. C. engine. Cost of tractor power.

Farm Machinery –Tillage implements: Primary and Secondary tillage implements, Implements for intercultural operations,
seed drills, field efficiency, paddy transplanters, Introduction of harvesting and threshing equipments.

Practical: Study of different component of I.C. Engine; Study of working of four stroke engine; Study of working of two
stroke engine; Study of M.B. plough, measurement of plough size, different parts, horizontal and vertical suction,
determination of line of pull etc.; Study of disc plough; Study of seed-cum-fertilizer drills-furrow openers, metering
mechanism and calibration; Study, maintenance and operation of tractor; Learning of tractor driving; Study, maintenance and
operation of power tiller; Study of different parts, registration, alignment and operation of mower. Study of different inter
cultivation equipment in term of efficiency, field capacity.

ENGG-221: Protected Cultivation and Post Harvest Technology

Green house technology; Introduction, Types of Green Houses, Green house equipment, materials of construction for
traditional and low cost green houses. Groundnut decorticators; hand operated and power operated decorticators, principles of
working, care and maintenance. Drying; grain drying, types of drying, types of dryers. Storage; grain storage, types of storage
structures. Fruits and vegetable grading; methods of grading, equipment for grading of fruits and vegetables. Size reduction;
equipment for size reduction, care and maintenance. Processing of cereals, pulses and oil seeds.

Practical: Study of different types of green houses based on shape, construction and cladding materials. Visit to commercial
green houses, Study of different components of groundnut decorticator. Study of improved grain storage structure, Study of

**ENGG-321: Renewable Energy**


**Practical:** Constructional details of KVIC and Deen Bandu type biogas plants; Field visit to biogas plants; To study and find the efficiency of solar cooker; Study and working of solar photovoltaic pumping system; Study and performance evaluation of domestic solar water heater; Study and performance evaluation of solar lantern; To study and performance evaluation of solar inverter; To study the performance of different types of wind mills; Field visit to wind mills; To study the processing of Bio-diesel production from Jatropha.

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**M.Sc. (Ag.) Courses**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>STAT 501</td>
<td>Statistical Methods for Applied Sciences</td>
<td>3(2+1)</td>
</tr>
</tbody>
</table>

**Theory**

**UNIT I**
Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

**UNIT II**
Discrete and continuous probability distributions: Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions. Large sample theory.

**UNIT III**
Practical

On the topics listed in the theory syllabus.

STAT 502      Experimental Designs                            3(2+1)

Theory
UNIT I
Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.
UNIT II
Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.
UNIT III
Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

Practical
On the topics listed in the theory syllabus.

STAT 511     Mathematical Methods for Applied Sciences     2(2+0)

Theory
UNIT I
Variables and functions; limit and continuity. Specific functions. Differentiation: theorems of differentiation, differentiation of logarithmic, trigonometric, exponential and inverse functions, function of a function, derivative of higher order, partial derivatives. Application of derivatives in agricultural research; maxima and minima in optimization.
UNIT II
Integration as a reverse process of differentiation, methods of integration, reduction formulae, definite integral; Applications of integration in agricultural research with special reference to economics and genetics, engineering.
UNIT III
Matrices, notations and operations, laws of matrix algebra; transpose and inverse of matrix; Eigen values and eigen vectors. Determinants - valuation and properties of determinants, application of determinants and matrices in solution of equation for economic analysis.
STAT 512      Non Parametric Tests and Multivariate Analysis        3(2+1)
Theory
UNIT I

UNIT II
Introduction to multivariate analytical tools- Hotelling’s $T^2$ Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, $D^2$-statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

Practical
On the topics listed in the theory syllabus.

Ph.D. Courses

1. Agricultural Statistics

STAT 601      SAMPLING TECHNIQUES        3(2+1)
Theory
UNIT I
Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population.
UNIT II
Simple random sampling, sampling for proportion, determination of sample size; inverse sampling, Stratified sampling.
UNIT III
Cluster sampling, PPS sampling, Multi-stage sampling, double sampling, systematic sampling; Use of auxiliary information at estimation as well as selection stages.
UNIT IV
Ratio and regression estimators. Construction and analysis of survey designs, sampling and non-sampling errors; Preparation of questionnaire Non-sampling errors.

Practical
On the topics listed in the theory syllabus.
**STAT 602  Advanced Statistical Computing  3(2+1)**

**Theory**

**UNIT I**

Measures of association. Structural models for discrete data in two or more dimensions.


**UNIT II**

Elements of inference for cross-classification tables. Models for nominal and ordinal response.

**UNIT III**

Computational problems and techniques for robust linear regression, nonlinear and generalized linear regression problem, tree-structured regression and classification, cluster analysis, smoothing and function estimation, robust multivariate analysis.

**UNIT IV**

Analysis of incomplete data: EM algorithm, single and multiple imputations. Markov Chain, Monte Carlo and annealing techniques, Neural Networks, Association Rules and learning algorithms.

**Practical**

On the topics listed in the theory syllabus.

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**STAT 603  Simulation Techniques  3(2+1)**

**Theory**

**UNIT I**

Review of simulation methods; Implementation of simulation methods – for various probability models, and resampling methods: theory and application of the jackknife and the bootstrap.

**UNIT II**

Correlograms, periodograms, fast Fourier transforms, power spectra, cross-spectra, coherences, ARMA and transfer-function models, spectral-domain regression. Simulated data sets to be analyzed using popular computer software packages

**UNIT III**

Stochastic simulation: Markov Chain, Monte Carlo, Gibbs' sampling, Hastings-Metropolis algorithms, critical slowing-down and remedies, auxiliary variables, simulated tempering, reversible-jump MCMC and multi-grid methods.

**Practical**

On the topics listed in the theory syllabus.
STAT 611  Advanced Statistical Methods  2+1

Theory

UNIT I

UNIT II
Introduction to the theory and applications of generalized linear models, fixed effects, random effects and mixed effects models, estimation of variance components from unbalanced data. Unified theory of least squares, MINQUE, MIVQUE, REML.

UNIT III

UNIT IV
Fitting of a generalized linear model, mixed model and variance components estimation, MINQUE, MIVQUE, REML.

Practical

On the topics listed in the theory syllabus.

STAT 612  Advanced Statistical Inference  3(2+1)

Theory

UNIT I
Robust estimation and robust tests, Robustness, M-estimates. L-estimates, asymptotic techniques, Bayesian inference. Detection and handling of outliers in statistical data.

UNIT II

UNIT III

UNIT IV

UNIT V
Concept of loss, risk and decision functions, admissible and optimal decision functions, a-priori and posteriori distributions, conjugate families. Bayes and Minimax decision rules and some basic results on them. Estimation and testing viewed as cases of decision problems. Bayes and Minimax decision functions with applications to estimation with quadratic loss function.

Practical
On the topics listed in the theory syllabus.

STAT 613 Advanced Design of Experiments 3(2+1)

Theory

UNIT I
General properties and analysis of block designs. Balancing criteria. \( m \)-associate PBIB designs, and their association schemes including lattice designs - properties and construction, Designs for test treatment – control(s) comparisons; Nested block designs, Mating designs.

UNIT II
General properties and analysis of two-way heterogeneity designs, Youden type designs, generalized Youden designs, Pseudo Youden designs. Structurally Incomplete block designs, Designs for two sets of treatments.

UNIT III
Balanced factorial experiments - characterization and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal arrays, Mixed orthogonal arrays, balanced arrays, Fractional replication, Regular and irregular fractions.

UNIT IV

Practical
On the topics listed in the theory syllabus.

STAT 614 Advanced Sampling Techniques 3(2+1)
Theory

UNIT I

UNIT II
Variance estimation in complex surveys. Taylor’s series linearisation, balanced repeated replication, Jackknife and bootstrap methods.

UNIT III
Unified theory of sampling from finite populations. UMV - Non-existence theorem and existence theorem under restricted conditions. Concept of sufficiency and likelihood in survey sampling. Admissibility and hyper-admissibility.

UNIT IV
Inference under super population models - concept of designs and model unbiasedness, prediction approach. Regression analysis and categorical data analysis with data from complex surveys. Domain estimation. Small area estimation.

Practical

On the topics listed in the theory syllabus.

STAT 616  Statistical Modeling  3(2+1)

Theory

UNIT I
Empirical and mechanistic models. Nonlinear growth models like monomolecular, logistic, Gompertz, Richards. Applications in agriculture and fisheries.

UNIT II

UNIT III

UNIT IV
Compartmental modelling - First and second order input-output systems, Dynamics of a multivariable system.

Practical
On the topics listed in the theory syllabus.

STAT 617  Advanced Time Series Analysis  3(2+1)

Theory

UNIT I
Multivariate time series: modelling the mean, stationary VAR models: properties, estimation, analysis and forecasting, VAR models with elements of nonlinearity, Non-stationary multivariate time series: spurious regression, co-integration, common trends.

UNIT II

UNIT III

UNIT IV
Non-linear programming, Kuhn-Tucker sufficient conditions, Elements of multiple objective programming, Dynamic Programming, Optimal control theory - Pontryagin’s maximum principle, Time-optimal control problems.

Practical

On the topics listed in the theory syllabus.

STAT 618  Stochastic Processes  3(2+1)

Theory

UNIT I

UNIT II

UNIT III
Renewal process: renewal process when time is discrete and continuous. Renewal function and renewal density. Statements of Elementary renewal theorem and Key renewal theorem.

UNIT IV

UNIT V
Elements of queueing process; the queuing model M/M/1: steady state behaviors. Birth and death process in queuing theory-Multi channel models. Network of Markovian queuing system.

UNIT VI
Branching process: Galton-Watson branching process. Mean and variance of size of nth generation, probability of ultimate extinction of a branching process. Fundamental theorem of branching process and applications.

Practical
On the topics listed in the theory syllabus.

STAT 619 Survival Analysis 3(2+1)

Theory

UNIT I
Measures of Mortality and Morbidity: Ratios and proportions, rates of continuous process, rates of repetitive events ,crude birth rate, Mortality measures used in vital statistics relationships between crude and age specific rates, standardized mortality ratios, evaluation of person-year of exposed to risk in long term studies, prevalence and incidence of a disease, relative risk and odds ratio.

Survival Distribution: Survival functions, hazard rate, hazard function, review of survival distributions: exponential, Weibull, Gamma, Rayleigh, Pareto, Lognormal~ IFR and TFRA, Gompertz and Makeham. Gompertz and logistic distributions. Parametric (m.l.e) estimation. Types of Censoring: Type I, Type II, random and other types of censoring, right and left truncated distributions. Expectation and variance of future life time, series and parallel system of failures.

Life Tables: Fundamental and construction.

UNIT II
Complete Mortality data, Estimation of Survival Function: Empirical survival function, estimation of survival function from grouped mortality data, joint distribution of the number of deaths, distribution of the estimation P covariance of estimate, estimation of curves of deaths and central death rate and force of mortality rate.

Incomplete Mortality data (non-parametric models): Actuarial method, m.l.e method, moment and reduced sample method of estimation and their comparison. Product limit (Kaplan-Meier) method and cumulative hazard function (CHF) of estimation of survival function.

UNIT III
Fitting Parametric Survival Distribution: Special form of survival function cumulative hazard function (CHF) plots, Nelson's method of ungrouped data, construction of the likelihood function for survival data, least squares fitting, fitting a Gompertz distribution to grouped data.

Some tests of Goodness of fit: Graphical, Kolmogorov-Smirnov statistics for complete, censored and truncated data, Chi-Square test and Anderson-Darling $A^2$-statistics.


UNIT IV

Gompertz distribution, parallel system and Weibull distribution, Fatal short models of failure. Two component series system.

Practical
On the topics listed in the theory syllabus.

STAT 651 Recent Advances In The Field of Specialization 1(1+0)

Theory
Recent advances in the field of specialization - sample surveys / design of experiments / statistical genetics / statistical modeling / econometrics / statistical inference, etc. will be covered by various speakers from the University / Institute as well as from outside the University / Institute in the form of seminar talks.
2. Agricultural Engineering (Soil & Water Conservation Engineering)

SWE 601 ADVANCED HYDROLOGY 3+0

Objective
To acquaint and equip the students with advanced hydrological process, analysis of hydrological data and their application for modeling.

Theory

UNIT I
Hydrologic models, processes and systems. Uncertainty in hydrological event. Statistical homogeneity.

UNIT II

UNIT III
Systems engineering for water management; Complexity of resources management process, systems analysis. Time series analysis. Markov processes.

UNIT IV
Formulation of various steps of statistical models and their application in hydrology.

Suggested Readings


SWE 602 SOIL AND WATER SYSTEMS’ SIMULATION AND MODELLING 2+1

Objective
To acquaint and equip the students with the simulation of soil water systems and modeling techniques.

**Theory**

**UNIT I**
Systems engineering for water management; Complexity of resources management process, systems analysis.

**UNIT II**
Rainfall-runoff models - Infiltration models, Simulation methods, structure of a water balance model.

**UNIT III**
Channel flow simulation - parameters and calibration - Streamflow statistics, surface water storage requirements.

**UNIT IV**
Flood control storage capacity; total reservoir capacity. Ground water models.

**UNIT V**
Design of nodal network, General systems frame work General –Numerical approaches.

**Practical**

Rainfall - Runoff models - Infiltration models - channel flow simulation problems - stream flow statistics – model parameters and input data requirements of various softwares of surface hydrology and groundwater – Hydrologic Modelling System – Soil Water Management Model – Use of dimensionless unit hydrograph

**Suggested Readings**


**SWE 603 MODELLING SOIL EROSION PROCESSES 2+1**

**Objective**
To acquaint and equip the students with the advance erosion process along with tools required and application of soil erosion models.

Theory

UNIT I
Overland flow, basic theory of particle movement and sediment transport; sediment deposition process.
UNIT II
Estimation of sediment load; mechanics of soil erosion by water and wind.
UNIT III
Water and wind erosion control measures.
UNIT IV
Universal soil loss equation; stochastic models and dynamic models.

Practical

Computation of soil erosion index; Estimation of soil erodibility factor; Design of erosion control structures.
Computation of suspended load and sediment load using empirical formulae; Application of sediment yield models, prediction of sediment loss – computation of reservoir sedimentation – sounding method.

Suggested Readings


SWE 604 ADVANCED HYDO-MECHANICS IN SOIL AQUIFER SYSTEMS 3+0

Objective

To acquaint and equip the students with the advance soil-aquifer-water mechanics and various techniques for the analysis of the system.

Theory

UNIT I
UNIT II
Determination of unsaturated hydraulic conductivity and models for its estimation.

UNIT III
Infiltration and exfiltration from soils in absence and presence of water table. Movement of groundwater in fractured and swelling porous media.

UNIT IV

Suggested Readings


SWE 605 HYDRO-CHEMICAL MODELLING & POLLUTANT MANAGEMENT 3+0

Objective
To acquaint and equip the students with the hydrodynamics of fluid and pollutant flow and the impact analysis of contaminant transport through modeling

Theory

UNIT I
Hydrodynamics in flow through porous media, Hydrodynamic dispersion, diffusion, convection equation.

UNIT II
Analytical and numerical models of contaminant transport in unsaturated soil profile and ground water.

UNIT III
Water quality management in lakes and reservoirs; physical characteristics; hydrologic and chemical budgets; biogeochemical processes of pollutants; assessment methods.

UNIT IV
Classical wastewater problems; Water reclamation, reuse, water quality constraints and considerations for reuse in irrigation and industry; Biological wastewater treatment.

UNIT V

Suggested Readings
SWE 606   PLANT GROWTH MODELLING AND SIMULATION  3+0

Objective

To acquaint and equip the students with the simulation and modeling techniques in the soil, plant and water environment for crop growth.

Theory

UNIT I
Introduction to crop growth modeling. Simulation and simulation techniques. Types of models and modeling approaches.

UNIT II
Relational diagram for principal process, structures of a generalized agricultural simulator.

UNIT III
Input environment and techniques of monitoring plant environment, process and aspect of growth and development. Input yield models.

UNIT IV
Quantitative analysis of plant processes light photo-syntheses, respiration, growth, water uptake etc. and their mathematical modeling.

Suggested Readings


SWE 607  ADVANCES IN IRRIGATION AND DRAINAGE  2+0

Objective
To acquaint and equip the students with the advance application of irrigation and drainage system along with applicability of various models.

**Theory**

**UNIT I**
Advances in surface irrigation systems- surge irrigation: effect of surging on surface flow hydraulics, cablegation: water supply management.

**UNIT II**
Atomization in sprinkler and micro irrigation system; multipurpose and special uses of micro irrigation.

**UNIT III**
Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems.

**UNIT IV**
Application of simulation models for drainage systems.

**Suggested Readings**


**SWE 608 REMOTE SENSING TECHNIQUES FOR NATURAL RESOURCES (2+1)**

**Objective**

To acquaint and equip the students with the techniques of remote sensing in natural resources.

**Theory**

**UNIT I**
Basic components of remote sensing, signals, sensors and sensing system; Characteristics of electromagnetic radiation and its interaction with matter;

**UNIT II**
Data acquisition system and ground truth; Satellite image acquisition; Visual and digital interpretation;

**UNIT III**
Spectral characteristics of vegetation, soil and water; interpretation; Spectral Characteristics of vegetation, soil and influence of water status;

UNIT IV

Soil moisture assessor; Soil degradation, soil salinity, water logging, soil erosion and conservation.

UNIT V

Land use inventory and planning; Water resource inventory-ground water, water monitoring.

Practical

Practical problems on above topics

Suggested Reading


SWE 609 WATER RESOURCES PLANNING AND MANAGEMENT (2+1)

Objective

To acquaint and equip the students with water resources optimization techniques for maximum output.

UNIT I

Introduction artificial ground water recharge; Method of artificial recharge.

UNIT II

Water balance approach in dry farming areas; Conjunctive use of surface and ground water utilization in command areas;

UNIT III

Land use inventory and planning; Water resource inventory-ground water, water monitoring.

UNIT IV

Formulation of resource allocation under constraints to achieve various goals.
Practical

Practical problems on above topics

Suggested Readings


3. Agricultural Engineering (Bio Process and Food Engineering)

BPFE-601: Advance Agricultural Processing for Value Addition: 3(2+1)

Introduction to various commonly prevalent value addition practices. Refrigeration as a means of value addition commodity storage requirements. Various freezing methods for different value added products. Frozen food storage and their moisture requirements during storage. Aseptic processing systems and thermal process calculations for stabilization of foods for shelf stable storage, sterilization value, thermal death time and use of TDT curve for food stabilization. Extrusion of foods; The food extruder, extrusion models, extrusion measurements and and experimentation. Extrusion equipments extrusion of starch and starchy materials textured plant proteins. Diffusion, extraction and leaching for value addition of foods. Effects of drying on microbiology of stored grains, fungal toxins in grains and seed during storage. Modified atmosphere storage and controlled atmosphere storage for value addition of food products. Role of salt starch, sugar, vitamins, preservatives and antioxidants for value addition. Use of Enzymes and fermentation in food preserving operations.

BPFE-602: Rheology Chemistry and Physics of Biological Materials: 3(2+1)

BPFE-603: Advance Food Engineering and Technology: 3(2+1)


BPFE-604: Advances in Grain Drying: 3(2+1)


BPFE-605: Storage Technology for Agricultural Produce: 3(2+1)

Introduction to various spoilage mechanisms of grains and seeds in the post harvest echo-systems, the resulting losses and strategies for prevention of stock. In storage respiration, bio heating and moisture migration is grains. Properties of grain responsible for production for heat and carbon dioxide during storage. Effect of various grain stabilization processes on the quality of stored grain. Effect of various storage parameters on viability and vigour of seed. In storage inspection and sampling of grains and seeds methods and means. In storage grain handling. In storage measurement of grain temperature and assessment of aeration requirement. Technology of grain storage in bulk and bags. Design considerations involved. Pressure in storage structures and its effect on flow characteristics of grains and viability of seeds. Influence of drying and storage condition on bio Physico chemical and nutritional quality of grains. Recent developments in grain storage technologies.

BPFE-606: Product Processing of Horticultural and Plantation Crops: 3(2+1)

Post harvest equipments, principles and techniques for preservation of foods and vegetables, colds storage, freezing, additives and chemical treatments, dehydration, canning and packaging. Manufacturing methods of major horticultural and plantation crop products such as juices, pickles, jams, jellies, marmalades, squash and purees.

BPFE-607: Equipment and Process for Confectionary and Convenience Food 3(2+1)
Equipments and manufacturing process for preparation of bread biscuits, cookies, toasts, buns and chocolates. Manufacture of extruded products such as noodles, licia, macaroni. Manufacture of roasted, popped, frilled and puffed food products and weaning food. Manufacture of cereal based high energy food items such as cakes, pastries and pizzas. Manufacture of soft drinks, ingredients and their effects on quality.
# List of Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td></td>
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<td>(Theory + Practical)</td>
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## B.Sc. (Ag.) Courses

### Core Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>GPB-111</td>
<td>Principles of Genetics</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-211</td>
<td>Principles of Plant Breeding</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-311</td>
<td>Breeding of Field / Horticulture Crops</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-321</td>
<td>Principles of Plant Biotechnology</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-322</td>
<td>Principles of Seed Technology</td>
<td>3(2+1)</td>
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## M.Sc. (Ag.) Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>GPB-501</td>
<td>Principles of Genetics</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-502</td>
<td>Principles of Cytogenetics</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-503</td>
<td>Principles of Plant Breeding</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-504</td>
<td>Principles of Quantitative Genetics</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>GPB-508</td>
<td>Cell Biology and Molecular Genetics</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-509</td>
<td>Biotechnology for Crop Improvement</td>
<td>3 (2+1)</td>
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## Optional Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>GPB-505</td>
<td>Mutagenesis and Mutation Breeding</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-506</td>
<td>Population Genetics</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-507</td>
<td>Heterosis Breeding</td>
<td>3 (2+1)</td>
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<tr>
<td>Course Code</td>
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<tr>
<td>GPB-510</td>
<td>Breeding for Biotic and Abiotic Stress Resistance</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-511</td>
<td>Breeding Cereals, Forages and Sugarcane</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>GPB-512</td>
<td>Breeding Legumes, Oilseeds and Fibre Crops</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-513</td>
<td>Breeding for Quality Traits</td>
<td>3 (2+1)</td>
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<tr>
<td>GPB-514</td>
<td>Gene Regulation and Expression</td>
<td>2(2+0)</td>
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<tr>
<td>GPB-515</td>
<td>Maintenance Breeding, Concepts of Variety Release and Seed Production</td>
<td>2(1+1)</td>
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<tr>
<td>GPB-516</td>
<td>Germplasm Collection, Exchange and Quarantine</td>
<td>3 (2+1)</td>
</tr>
<tr>
<td>GPB-517</td>
<td>Data Base Management, Evaluation and Utilization of PGR</td>
<td>3 (2+1)</td>
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**Master's Seminar and Research**

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<tbody>
<tr>
<td>GPB-550</td>
<td>Master’s Course Seminar</td>
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<tr>
<td>GPB-560</td>
<td>Master’s Research (Thesis)</td>
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**Ph.D. Course**

<table>
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<th>Course Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>GPB-603</td>
<td>Genomics in Plant Breeding</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-604</td>
<td>Molecular and Chromosomal Manipulations for Crop Breeding</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>GPB-605</td>
<td>Advances Plant Breeding Systems</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>GPB-691</td>
<td>Doctoral Seminar I (RPP non-credit)</td>
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**Optional Courses**

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<thead>
<tr>
<th>Course Code</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>GPB-601</td>
<td>Plant Genetic Resources and Pre-Breeding</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>GPB-602</td>
<td>Advances in Biometrical and Quantitative Genetics</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-606</td>
<td>Crop-Evolution</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>GPB-607</td>
<td>Breeding Designer Crops</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-608</td>
<td>Advances in Breeding of Major Field Crops</td>
<td>3(3+0)</td>
</tr>
<tr>
<td>GPB-609</td>
<td>Microbial Genetics</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>GPB-610</td>
<td><em>In-situ</em> and <em>ex-situ</em> Conservation of Germplasm</td>
<td>3(2+1)</td>
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</tbody>
</table>
Doctoral Research and Seminar

GPB-650  Research Plan Proposal Seminar  0
GPB-651  Doctoral Seminar  1(1+0)
GPB-652  Pre Submission Ph.D. Thesis Seminar  0
GPB-660  Doctoral Research  45

B.Sc. (Ag.) Courses

GPB-111. Principles of Genetics  3 (2+1)

Mendel’s laws of inheritance and exceptions to the laws; Types of gene action, Multiple alleles, Pleiotropism, Penetrance and expressivity; Quantitative traits, Qualitative traits and differences between them; Multiple factor hypothesis; Cytoplasmic inheritance, it’s characteristic features and difference between chromosomal and cytoplasmic inheritance; Mutation and it’s characteristic features; Methods of inducing mutations and C / B technique. Gene expression and differential gene activation; Lac operon and Fine structure of Gene; Ultra structure of cell and cell organelles and their functions; Study of chromosome structure, morphology, number and types, Karyotype and Idiogram; Mitosis and meiosis, their significance and differences between them; DNA and it’s structure, function, types, modes of replication and repair. RNA and its structure, function and types; Transcription, Translation, Genetic code and outline of protein synthesis; Crossing over and factors affecting it; Mechanism of crossing over and Cytological proof of crossing over; Linkage, Types of linkage and estimation of linkage; Numerical chromosomal aberrations (Polyploidy) and evolution of different crop species like Cotton, Wheat, Tobacco, Triticale and Brassicas; Structural chromosomal aberrations.

Practical:

Microscopy (Light microscopes and electron microscopes); Preparation and use of fixatives and stains for light microscopy; Preparation of micro slides and identification of various stages of mitosis; Preparation of micro slides and identification of various stages of meiosis; Monohybrid ratio and its modifications; Dihybrid ratio and its modifications; Trihybrid ratio; Chi-square analysis and Interaction of factors; Epistatic factors, Supplementary factors and Duplicate factors; Complementary factors, Additive factors and Inhibitory factors; Linkage – Two point test cross; Linkage – Three point test cross; Induction of polyploidy using colchicines; Induction of chromosomal aberrations using chemicals.

GPB-211. Principles of Plant Breeding  3(2+1)

Classification of plants, Botanical description, Floral biology, Emasculation and Pollination techniques in cereals, millets, pulses, oil seeds, fibers, plantation crops etc. Aims and objectives of Plant Breeding; Modes of reproduction, Sexual, Asexual, Apomixis and their classification; Significance in plant breeding; Modes of pollination, genetic
consequences, differences between self and cross pollinated crops; Methods of breeding – introduction and acclimatization. Selection, Mass selection Johannson’s pure line theory, genetic basis, pure line selection; Hybridization, Aims and objectives, types of hybridization; Methods of handling of segregating generations, pedigree method, bulk method, back cross method and various modified methods; Incompatibility and male sterility and their utilization in crop improvement; Heterosis, inbreeding depression, various theories of Heterosis, exploitation of hybrid vigour development of inbred lines, single cross and double cross hybrids; Population improvement programmes, recurrent selection, synthetics and composites; Methods of breeding for vegetatively propagated crops; Clonal selection; Mutation breeding; Ploid breeding; Wide hybridization, significance in crop improvement.

Practical: Botanical description and floral biology; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic plant; Plant Breeder’s kit; Hybridization techniques and precautions to be taken; Floral morphology, selfing, emasculation and crossing techniques; Study of male sterility and incomapribility in field plots; Rice and Sorghum; Maize and Wheat; Bajra and ragi; Sugarcane and coconut; Groundnut, Castor, Safflower and Sesamum; Redgram, Bengalgram and Greengram; Soybean and blackgram; Chillies, Brinjal and Tomato; Bhendi, Onion, Bottle gourd and Ridge gourd; Cotton and Mesta; Jute and Sunhemp

GPB-311. Breeding of Field / Horticulture Crops

Breeding objectives and important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Hardy-Weinberg Law; Study in respect of origin, distribution of species, wild relatives and forms, Cereals, (rice, wheat, maize, millets, sorghum, bajra, ragi); Pulses (redgram, greengram, blackgram, soybean); Oilseeds (Groundnut, sesame, sunflower, safflower, castor, mustard) etc. Fibers (Cotton, kenaf, roselle, jute) etc. Vegetables (Tomato, bhindi, chilli, cucumbers); Flower crops (Chrysanthemum, rose, galardia, gerbera & marigold); Fruit crops (aonla, guava, mango, custard apple, banana, papaya); Major breeding procedures for development of hybrids / varieties of various crops; Plant Genetic Resources their conservation and utilization in crop improvement; Ideotype concept in crop improvement; Breeding for resistance to biotic and abiotic stresses variability in pathogens and pests; Mechanisms of resistance in plant to pathogens and pest; Genetic basis of adaptability to unfavourable environments; Definition of biometrics, assessment of variability ditive, dominance and epistasis and their differentiation; Genotype x Environment interaction and influence on yield/performance. IPR and its related issues.

Practical: Emasculation and Hybridization techniques; Handling of segregating generations, pedigree methods; Handling of segregating generations, bulk methods; Handling of segregating generations, back cross methods; Field lay out of experiments; Field trials, maintenance of records and registers; Estimation of Heterosis and inbreeding depression; Estimation of Heritability, GCA and SCA; Estimation of variability parameters; Parentage of released varieties/hybrids; Problems on Hardy, Weinberg Law; Study of quality characters; Sources of donors for different characters; Visit to seed production and certification plots; Visit to AICRP trials and programmes; Visit to grow out test plots; Visit to various research stations; Visit to other institutions
4. GPB-321. Principles of Plant Biotechnology


**Practical:** Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production technology; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoricsis techniques.

GPB 322 Principles of Seed Technology

Introduction to Seed Production, Importance of Seed Production, Seed policy, Seed demand forecasting and planning for certified, foundation and breeder seed production, Deterioration of crop varieties, Factors affecting deterioration and their control; Maintenance of genetic purity during seed production, Seed quality; Definition, Characters of good quality seed, Different classes of seed, Production of nucleus & breeder’s seed, Maintenance and multiplication of pre-release and newly released varieties in self and cross-pollinated crops; Seed Production, Foundation and certified seed production in maize (varieties, hybrids, synthetics and composites); Foundation and certified seed production of rice (varieties & hybrids); Foundation and certified seed production of sorghum and bajra (varieties, hybrids, synthetics and composites); Foundation and certified seed production of cotton and sunflower (varieties and hybrids); Foundation and certified seed(varieties and hybrids) production of castor, tomato, brinjal, chillies, bhendi, onion, bottle gourd and ridge gourd; Seed certification, phases of certification, procedure for seed certification, field inspection and field counts etc.; Seed Act and Seed Act enforcement, Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency,
Central and State Seed Testing Laboratories; Duties and powers of seed inspectors, offences and penalties; Seed control order: Seed Control Order 1983, Seed Act 2000 and other issues related to seed quality regulation. Intellectual Property Rights, Patenting, WTO, Plant Breeders Rights, Varietal Identification through Grow-Out Test and Electrophoresis; Seed Drying: Forced air seed drying, principle, properties of air and their effect on seed drying, moisture equilibrium between seed and air, Heated air drying, building requirements, types of air distribution systems for seed drying, selection of crop dryers and systems of heated air drying, recommended temperature and depth of the seeds, management of seed drying, Planning and layout of seed processing plant; Establishment of seed processing plant. Seed processing: air screen machine and its working principle, different upgrading equipments and their use, Establishing a seed testing laboratory. Seed testing procedures for quality assessment, Seed treatment, Importance of seed treatment, types of seed treatment, equipment used for seed treatment (Slurry and Mist–O–matic treater), Seed packing and seed storage, stages of seed storage, factors affecting seed longevity during storage and conditions required for good storage, General principles of seed storage, constructional features for good seed warehouse, measures for pest and disease control, temperature control, Seed marketing, marketing structure, marketing organization, sales generation activities, promotional media, pricing policy; Factors affecting seed marketing.

Practical: Seed sampling principles and procedures; Physical Purity analysis of Field and Horticultural crops; Germination analysis of Field and Horticultural crops; Moisture tests of Field and Horticultural crops; Viability test of Field and Horticultural crops; Seed health test of Field and Horticultural crops; Vigour tests of Field and Horticultural crops; Seed dormancy and breaking methods; Grow out tests and electrophoresis for varietal identification; Visit to Seed production plots of Maize, Sunflower, Bajra, Rice, Sorghum, Cotton, Chillies and Vegetables. (Add or delete crops of the region); Visit to Seed processing plants; Visit to Seed testing laboratories; Visit to Grow out testing farms; Visit to Hybrid Seed Production farms; Varietal identification in seed production plots; Planting ratios, isolation distance, roguing etc

M.Sc. (Ag.) Courses

GP 501  Principles of Genetics  3(2+1)

Theory

UNIT I

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel’s paper, Chromosomal theory of inheritance.
UNIT II
Multiple alleles, Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

UNIT III

UNIT IV
Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

UNIT V
Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT VI
Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression.
Gene regulation in eukaryotes, RNA editing.

UNIT VII
Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

UNIT VIII
Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

UNIT IX
Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts.

UNIT X
Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

**Practical**

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification - Electrophoresis – basic principles and running of amplified DNA - Extraction of proteins and isozymes – use of Agrobacterium mediated method and Biolistic gun; practical demonstrations - Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

**GP 502 Principles of Cytogenetics**

**Theory**

UNIT I

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

UNIT II

Chromosomal theory of inheritance – Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synopsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - in situ hybridization and various applications.

UNIT III

Structural variation in chromosomes – their cytogenetical consequences, gene mapping and other uses; Deficiencies, duplications, inversions and interchanges; Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

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UNIT IV

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids -- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.
UNIT V
Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species.

UNIT VI
Fertilization barriers in crop plants at pre and post fertilization levels- In vitro techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical
Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and Aloe vera - Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops -Various methods of staining and preparation of temporary and permanent slides - Pollen germination in vivo and in vitro; Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture – Morphological observations on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibre assembly – Morphological observations on allopolyploids - Morphological observations on aneuploids

- Cytogenetic analysis of interspecific and intergeneric crosses - Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops. -Fluorescent in situ hybridization (FISH)- Genome in situ hybridization GISH.

GP 503 Principles of Plant Breeding 3(2+1)

Theory
UNIT I
History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

UNIT II
Genetic basis of breeding self- and cross-pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

UNIT III
Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

UNIT IV
Breeding methods in cross-pollinated crops; Selection, Response to Selection; Population breeding-mass selection and ear-to-row methods; $S_1$ and $S_2$ progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT V
Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.

UNIT VI
Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding.

UNIT VII
Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

UNIT VIII
Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders’ rights and regulations for plant variety protection and farmers rights.

Practical
Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

GP 504 Principles of Quantitative Genetics 3(2+1)
Theory

UNIT I
Mendelian traits Vs polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

UNIT II

Principles of Analysis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and 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; AMMI analysis – principles and interpretation.

UNIT V

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis.

Practical

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - 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 - Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadrallel analysis and Triple
Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model – Principal Component Analysis model - Additive and multiplicative model – Shifted D$_1$ multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.

**Objective**

To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advances made.

**Theory**

**UNIT I**


**UNIT II**

Mutagenic agents: physical -- Radiation types and sources: Ionising and non-ionizing radiations viz., X rays, γ rays and β particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships.

**UNIT III**

Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects - Dosimetry - Objects and methods of treatment - Factors influencing mutation: dose rate, acute Vs. chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: External and internal sources- Oxygen, water content, temperature and nuclear volume.

**UNIT IV**

Chemical mutagens- Classification - Base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis - Treatment methods using physical and chemical mutagens – Combination treatments; Other causes of mutation - direct and indirect action, comparative evaluation of physical and chemical mutagens.

**UNIT V**
Observing mutagen effects in M₁ generation: plant injury, lethality, sterility, chimeras etc., - Observing mutagen effects in M₂ generation - Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations - – Mutations in traits with continuous variation.

UNIT VI

Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage etc. - Individual plant based mutation analysis and working out effectiveness and efficiency in M₃ generation - Comparative evaluation of physical and chemical mutagens for creation of variability in the same species – Case studies.

UNIT VII

Use of mutagens in creating oligogenic and polygenic variations – Case studies - *in vitro* mutagenesis – callus and pollen irradiation; Handling of segregating generations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc) in different crops - Procedures for micromutations breeding/polygenic mutations - Achievements of mutation breeding - varieties released across the world- Problems associated with mutation breeding.

UNIT VIII

Use of mutagens in genomics, allele mining, TILLING.

**Practical**

Learning the precautions on handling of mutagens; Dosimetry - Studies of different mutagenic agents: Physical mutagens - Studies of different mutagenic agents: Chemical mutagens - Learning on Radioactivity – Production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards - Monitoring – safety regulations and safe transportation of radioisotopes - Visit to radio isotope laboratory; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagules at different doses of physical and chemical mutagens - Learning combined mutagenic treatments; Raising the crop for observation - Mutagenic effectiveness and efficiency; Calculating the same from earlier literature - Study of 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.
Theory

UNIT I
Population - Properties of population - Mendelian population – Genetic constitution of a population through time, space, age structure etc. Mating systems - Random mating population - Frequencies of genes and genotypes-Causes of change: population size, differences in fertility and viability, migration and mutation.

UNIT II
Hardy-Weinberg equilibrium - Hardy-Weinberg law - Proof – Applications of the Hardy-Weinberg law - Test of Hardy-Weinberg equilibrium – Mating frequencies - Non-dominance - Codominance - Snyder’s ratio, importance and its effect over random mating in succeeding generations.

UNIT III
Multiple alleles - More than one locus - Sex linked genes; Use of gene and genotypic frequencies evaluation in field population level; Interpretations - Changes of gene frequency - Migration – Mutation - Recurrent and nonrecurrent - Selection - Balance between selection and mutation – Selection favouring heterozygotes - Overdominance for fitness.

UNIT IV

UNIT V
Gene substitution and average effects; Breeding value- Genetic drift; Genetic slippage, Co-adapted gene complexes; Homoeostasis- Adapative organization of gene pools, Polymorphism- Balanced and Non-balanced polymorphism, heterozygous advantage- Survival of recessive and deleterious alleles in populations.

Practical
Genetic exercise on probability; Estimation of gene frequencies; Exercises on factors affecting gene frequencies; Estimation of average affect of gene substitution and breeding value; Exercises on inbreeding and linkage disequilibrium; Exercises of different mating designs; Estimation of different population parameters from experimental data.
GP 507 Heterosis Breeding

Theory

UNIT I

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops.

UNIT II

Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis. UNIT III

Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F_2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of Heterosis – case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

UNIT IV

Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of selfincompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.

UNIT V

Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated’ crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.

UNIT VI

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

UNIT VII

Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum, pigeonpea and oilseed crops.

Practical
Selection indices and selection differential – Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for Heterosis parameters - Hybrid seed production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

GP 508 Cell Biology and Molecular Genetics 3(2+1)

Theory
UNIT I
Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastidschloroplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

UNIT II
Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division.

UNIT III
Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

UNIT IV
Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

Practical
Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method;
Determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.
GP 509 Biotechnology for Crop Improvement 3(2+1)

Theory

UNIT I
Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II
Tissue culture- History, callus, suspension cultures, cloning; Regeneration Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III
Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH).

UNIT IV
Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

UNIT V
Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI
Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

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

UNIT VIII
GMOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights

UNIT IX
Bioinformatics & Bioinformatics tools.
UNIT X

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory - Techniques in plant tissue culture - Media components and media preparation - Aseptic manipulation of various explants; observations on the contaminants occurring in media - interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using Agrobacterium strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes.

GP 510 Breeding for Biotic and Abiotic Stress Resistance 3(2+1)

Theory

UNIT I

Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT II

Types and genetic mechanisms of resistance to biotic stresses – Horizontal and vertical resistance in crop plants. Quantitative resistance / Adult plant resistance and Slow rusting resistance - Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies.

UNIT III

Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT IV

Classification of abiotic stresses - Stress inducing factors – moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.
UNIT V

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging & submersion, high and low/freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

UNIT VI

Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management- Achievements.

Practical

Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level - Phenotypic screening techniques for nematodes and borers; Ways of combating them; Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance; Use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity-their effects and breeding strategies; Understanding the climatological parameters and predisposal of biotic and a biotic stress factors- ways of combating them.

GP 511 Breeding Cereals, Forages and Sugarcane 3(2+1)

Theory

UNIT I

Rice: Evolution and distribution of species and forms - wild relatives and germplasm; Genetics – cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc. Hybrid rice breeding- potential and outcome - Aerobic rice, its implications and drought resistance breeding.

UNIT II

Wheat: Evolution and distribution of species and forms - wild relatives and germplasm; cytogenetics and genome relationship; Breeding objectivesyield, quality characters, biotic and abiotic stress resistance, exploitation of heterosis etc; Sorghum: Evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc; Pearl millet:
Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc.

UNIT III

Maize: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc - QPM and Bt maize – strategies and implications - Heterosis breeding attempts taken in Sorghum, Pearl Millet and Maize; Minor millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - Minor millets: breeding objectives yield, quality characters, biotic and abiotic stress resistance etc.

UNIT IV

Sugarcane: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Forage grasses: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance etc., synthetics, composites and apomixes.

UNIT V

Forage legumes: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Tree fodders: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc, palatability studies.

UNIT VI

Distinguishing features of popular released varieties in Rice and Sorghum - Wheat, Pearl millet, Maize and other millets - Sugarcane, forage grasses and legumes and their application to DUS testing - Maintenance of seed purity - Nucleus and Breeder Seed Production.

Practical

Floral biology – emasculation - pollination techniques; Study of range of variation for yield and yield components – Study of segregating populations and their evaluation - Trait based screening for stress resistance in crops of importance– Use of descriptors for cataloguing Germplasm maintenance; learning on the Standard Evaluation System (SES) and descriptors; Use of softwares for database management and retrieval.Practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories, learning the practice of value addition; visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.
Theory

UNIT I

Pigeonpea: Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship; Morphological and molecular descriptors used for differentiating the accessions; Breeding objectives- yield, quality characters, biotic and abiotic stress etc - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

UNIT II

Chickpea: Evolution and distribution of species and forms - Wild relatives and germplasm - cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Protein quality improvement; Conventional and modern plant breeding approaches, progress made - Breeding for anti nutritional factors.

UNIT III

Other pulses: Greengram, blackgram, fieldpea, lentil,, lathyrus, cowpea, lablab, mothbean: Evolution, cytogenetics and genome relationship; Learning the descriptors; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT IV

Groundnut: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Pod and kernel characters; Breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT V

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

UNIT VI

Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc. - Oil quality – characteristics; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

UNIT VII

Other oilseed crops: Sunflower, sesame, safflower, niger: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic
stress; Sunflower: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

UNIT VIII

Castor: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, breeding objectives yield, quality characters, biotic and abiotic stress etc - Hybrid breeding in castor – opportunities, constraints and achievements.

UNIT IX

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc; Mesta and minor fibre crops: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT X

Distinguishing features of the released varieties in pulses, oilseeds and cotton; Maintenance of seed purity and seed production.

Practical

Use of descriptors for cataloguing – Floral biology - emasculation – pollination techniques; Study of range of variation for yield and yield components - Study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops; Attempting crosses between blackgram and greengram. Use of descriptors for cataloguing – Floral biology, emasculation, pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor, Cotton: Use of descriptors for cataloguing – Floral biology - Learning on the crosses between different species - Cotton: Study of range of variation for yield and yield components - Study of segregating populations - evaluation - Trait based screening for stress resistance - Cotton fibre quality evaluation – conventional and modern approaches; analysing the lint samples of different species, interspecific and interracial derivatives for fibre quality and interpretation –Development and maintenance of male sterile lines Evaluation of cotton cultures of different species for insect and disease resistance – Learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and resistance parameters – learning the procedures on development of Bt cotton - Visit to Cotton Technology Laboratory and Spinning Mills – Learning on cotton yarn production, its quality evaluation and uses.

GP 513 Breeding For Quality Traits 3(2+1)

Theory
UNIT I
Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, aminoacids and anti-nutritional factors - Nutritional improvement - A human perspective - Breeding for grain quality parameters in rice and its analysis - Golden rice and aromatic rice – Breeding strategies, achievements and application in Indian context - Molecular basis of quality traits and their manipulation in rice - Post harvest manipulation for quality improvement.

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

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

UNIT IV
Breeding for quality in pulses - Breeding for quality in groundnut, sesame, sunflower and minor oilseeds – Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for quality improvement in cotton.

UNIT V
Genetic engineering protocols for quality improvement – Achievements made - Value addition in crops; Classification and importance – Nutritional genomics and Second generation transgenics.

Practical
Grain quality evaluation in rice; Correlating ageing and quality improvement in rice - Quality analysis in millets; Estimation of antinutritional factors like tannins in different varieties/hybrids; A comparison - Quality parameters evaluation in wheat; Quality parameters evaluation in pulses - Quality parameters evaluation in oilseeds; Value addition in crop plants ; Post harvest processing of major field crops; Quality improvement in crops through tissue culture techniques; Evaluating the available populations like RIL, NIL etc. for quality improvement using MAS procedures.

GP 514       Gene Regulation And Expression       2(2+0)
Theory
UNIT I
Introduction: Gene regulation-purpose; Process and mechanisms in prokaryotes and eukaryotes; Levels of gene controls.

UNIT II

Coordinated genetic regulation-examples- Anthocyanin and gene families and maize.

UNIT III

Gene expression-Transposons in plant gene expression, Paramutations and imprinting of genes and genomes.

UNIT IV

Transgene expression and gene silencing mechanisms; Regulatory genes horizontal and vertical homology; Transformation regulatory genes as visible markers.

UNIT V

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

GP 515 Maintenance Breeding and Concepts of Variety Release and Seed Production 2(1+1)

Theory

UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers’ variety, hybrid, and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication - nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearl millet, sorghum, maize and
ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne); Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops.

GP 516       Germplasm Collection, Exchange And Quarantine       3(2+1)

Theory

UNIT I

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

UNIT II

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of in vitro methods in germplasm collection.

UNIT III

Ethnobotanical aspects of PGR; Crop botany, farming systems, collecting wild relatives of crop plants; Collection and preservation of specimens; Importance and use of herbaria and preparation of herbarium specimens.

UNIT IV

Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, Brassica, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge.

UNIT V
History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).

UNIT VI

Detection and identification of pests including use of recent techniques like ELISA, PCR etc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

UNIT VII

Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

Practical

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports, airports to study the quarantine regulations; Techniques for the detection of insects, mites, nematodes, bacteria, weeds, pathogens and viruses on seed and planting materials and salvaging; Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc); Detection of GMOs and GEPs; Study of post-entry quarantine operation, seed treatment and other prophylactic treatments.

GP 517 Data Base Management, Evaluation And Utilization Of PGR 3(2+1)

Theory

UNIT I

Statistical techniques in management of germplasm; Core identification, estimation of sample size during plant explorations, impact of sampling on population structure, sequential sampling for viability estimation; Introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability equations and numograms; Estimation of sample size for storage and viability testing.

UNIT II
Germplasm documentation; Basics of computer and operating systems; Database management system, use of statistical softwares, pictorial and graphical representation of data; introduction to communication network.

UNIT III

Germplasm management system- global scenario; Genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections; necessity of germplasm evaluation; Predictive methods for identification of useful germplasm; Characterization of germplasm and evaluation procedures including specific traits; Gene markers and their use in PGR management.

UNIT IV

Management and utilization of germplasm collections; Concept of core collection, molecular markers and their use in characterization; Evaluation and utilization of genetic resources; Pre-breeding/ genetic enhancement, utilizing wild species for crop improvement; Harmonizing agrobiodiversity and agricultural development crop diversification participatory plant breeding.

Practical

Basics of computer and operating systems; Identification of useful germplasm, evaluation of crop germplasm; Statistical techniques in management of germplasm- estimation of sample size for storage and viability testing; Evaluation procedure and experimental protocols (designs and their analysis), Assessment of genetic diversity; Techniques of Characterization of germplasm; Molecular markers and their use in characterization.

Ph.D. Course

GP 601    Plant Genetic Resources And Pre-Breeding  2(2+0)

Theory

UNIT I

Historical perspectives and need for PGR conservation; Importance of plant genetic resources; Taxonomical classification of cultivated plants; Gene pool: primary, secondary and tertiary; Centres of origin and global pattern of diversity; Basic genetic resources and transgenes.

UNIT II

Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of in vitro and cryopreservation.
UNIT III

Germplasm conservation- *in situ*, *ex situ*, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; Registration of plant genetic resources.

UNIT IV

PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing; Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges; Seed Act, *sui generis* system; Geographical indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets.

UNIT V

Journey from wild to domestication; Genetic enhancement- need for genetic enhancement; Genetic enhancement in pre Mendelian era and 21st century; Genetic enhancement and plant breeding; Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.

UNIT VI

Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression.

UNIT VII

Post-genomic tools for genetic enhancement of germplasm; Prebreeding through chromosome manipulation; Application of biotechnology for Genetic enhancement-Achievements.

UNIT VIII

Utilization of genetic resources, concept of core and mini-core collections, genetic enhancement/Prebreeding for crop improvement including hybrid development.

**GP 602** Advances in Biometrical and Quantitative Genetics 3(2+1)

**Theory**

UNIT I

Basic principles of Biometrical Genetics; Selection of parents; Advanced biometrical models for combining ability analysis; Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes;

Designs and Systems; Selection of stable genotypes.

UNIT II
Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Principal Component Analysis.

UNIT III
Additive and multiplicative model - Shifted multiplicative model; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes.

UNIT IV
Genetic architecture of quantitative traits; Conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance – Construction of saturated linkage maps, concept of framework map development; QTL mapping- Strategies for QTL mapping - desired populations, statistical methods; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

Practical
Working out efficiency of selection methods in different populations and interpretation - Biparental mating – use of softwares in analysis and result interpretation - Triallel analysis– use of softwares in analysis and result interpretation - Quadriallel analysis – use of softwares in analysis and result interpretation - Triple Test Cross (TTC) – use of softwares in analysis and result interpretation - Advanced biometrical models for combining ability analysis - Selection of stable genotypes using stability analysis; Models in stability analysis, Additive Main Effect and Multiplicative Interaction (AMMI) model - Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes. Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

GP 603 Genomics in Plant Breeding 3(2+1)

Theory
UNIT I
Introduction to the plant genome- Plant nuclear genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity.

UNIT II
Establishment of plant genome mapping projects - Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci; Approaches to apply Marker Assisted Selection (MAS) in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Map based cloning of plant genes.

UNIT IV

Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics– Genome Comparison Techniques- Classical and advanced approaches.

UNIT V

Detection of Single Nucleotide Polymorphism; TILLING and Eco- TILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping.

UNIT VI

Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical


GP 604 Molecular And Chromosomal Manipulations For Crop Breeding 2(2+0)

Theory

UNIT I

Organization and structure of genome – Genome size – Organization of organellar genomes – Nuclear DNA organization – Nuclear and Cytoplasmic genome interactions and signal transduction; Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content – C value paradox; Sequence complexity – Introns and Exons – Repetitive sequences – Role of repetitive sequence.

UNIT II
Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, localization and mapping of genes/genomic segments; Distant hybridization - Role of polyploids in crop evolution and breeding - auto and allopolyploids.

UNIT III

Applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchange genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes-linked marker methods; Duplication - production and use; Inversions and location of genes; B/A chromosome translocations and gene location.

UNIT IV

Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics-methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and non-allelic interactions; Telocentric method of mapping.

UNIT V


GP 605 Advances In Plant Breeding Systems 2(2+0)

Theory

UNIT I

Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.

UNIT II

Self- incompatability and sterility – Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility - Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility – Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.
UNIT III

Population formation by hybridization - Types of populations – Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.

UNIT IV

Selection in self fertilizing crops; Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations Vs advanced generations); Backcross, polycross and test cross.

UNIT V

Selection in cross fertilizing crops – Polycross and topcross selections, Mass and recurrent selection methods and their modifications – Mass selection: grided mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) - Recurrent selection for general combining ability (GCA) – Concepts and utilization - Recurrent selection for specific combining ability (SCA) – usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.

UNIT VI

Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatability and sterility in plant breeding – case studies; - Fertility restoration in male sterile lines and restorer diversification programmes - Conversion of agronomically ideal genotypes into male steriles – Concepts and breeding strategies; Case studies - Generating new cytonuclear interaction system for diversification of male steriles - Stability of male sterile lines – Environmental influence on sterility– Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic male sterility and its use heterosis breeding - Apomixis and its use in heterosis breeding - Incongruity – Factors influencing incongruity - Methods to overcome incongruity mechanisms.
UNIT III
Speciation and domestication – The process of speciation – Reproductive isolation barriers – Genetic differentiation during speciation – Hybridization - speciation and extinction.

UNIT IV
Exploitation of natural variation – Early attempts to increase variation – Distant hybridization and introgression- Interspecific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer into cultivated species, tools and techniques; Validation of transferred genes and their expression; Controlled introgressions.

UNIT V
Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization; Genome organization – Transgenesis in crop evolution – Multifactorial genome – Intragenomic interaction – Intergenomic interaction – Genome introgression.

UNIT VI
Methods to study crop evolution - Contemporary Methods – Based on morphological features – Cytogenetic analysis – Allozyme variations and crop evolution – DNA markers, genome analysis and comparative genomics.

UNIT VII

UNIT VIII
Visit to Centres of Crop Diversity within the country.

GPB 607 Breeding Designer Crops 3(2+1)

Theory

UNIT I
Breeding of crop ideotypes; Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds-proteins, vaccines, gums, starch and fats.

UNIT II
Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode; Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement.

UNIT III
Improvement in yield potential under sub-optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.

UNIT IV
Breeding for special traits viz. oil, protein, vitamins, amino acids etc.; Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming.

UNIT V
Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management.

Practical
Demonstration of plant responses to stresses through recent techniques; Water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/drought/salt shock proteins.
UNIT I

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice, Wheat, Maize, Pearl millet, Sorghum, Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.

UNIT II

Breeding objectives in rice, wheat, maize, pearl millet, sorghum, pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization; Genetics of quantitative and qualitative traits.

UNIT III

Breeding for value addition and resistance to abiotic and biotic stresses.

UNIT IV

Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

UNIT V

National and International accomplishments in genetic improvement of major field crops and their seed production.

UNIT I

Nature of bacterial variation; Molecular aspects of mutation; Episomes and plasmids; Gene mapping in bacteria; Life cycle of bacteriophages; Genetic fine analysis of rII locus; Circular genetic map of phage T4; Transposable elements; Gene manipulation; Biochemical genetics of Neurospora and Sacharomyces; One gene - one enzyme hypothesis.

UNIT II

Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Molecular chaperones and gene expression; Genetic basis of apoptosis.

UNIT III
Transgenic bacteria and bioethics; genetic basis of nodulation, nitrogen fixation and competition by rhizobia, genetic regulation of nitrogen fixation and quorum sensing in rhizobia; genetics of mitochondria and chloroplasts.

Practical
Preparation and sterilization of liquid and agar bacterial nutrient media; Assessment of generation time in the log-phae bacterial cultures. Handling of microorganisms for genetic experiments; Isolation of rhizobia from nodules; Gram staining of rhizobial cells; Examination of polyhydroxy butyrate (PHB) production in rhizobia; Demonstration of $N_2$-fixing nodules/bacterial inoculation in the legume- Rhizobium symbiotic system. Induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria; determination of spontaneous and induced mutation frequencies; Discrete bacterial colony counts for the preparation of survival curves and determination of LD$_{50}$ of a mutagen.

GPB 610  In Situ And Ex Situ Conservation Of Germplasm  3(2+1)

Theory
UNIT I
Concept of natural reserves and natural gene banks, In situ conservation of wild species in nature reserves: in situ conservation components, factors influencing conservation value, national plan for in situ conservation; in situ conservation of agro-biodiversity on-farm; scientific basis of in situ conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of in situ conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

UNIT II
Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma-frost conservation, guidelines for sending seeds to network of active/working collections, orthodox, recalcitrant seeds- differences in handling, clonal repositories, genetic stability under long term storage condition.

UNIT III
In vitro storage, maintainence of in vitro culture under different conditions, in vitro bank maintainence for temperate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of in vitro gene bank.

UNIT IV
Cryopreservation- procedure for handling seeds of orthodox and recalcitrants-cryoprotectants, dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agriculture, horticulture and forestry crops. Problems and prospects; challenges aheads.

**Practical**

*In situ* conservation of wild species – case studies at national and international levels- *ex situ* techniques for active and long-term conservation of collections - Preparation and handling of materials, packaging, documentation; design of cold storage modules- Conservation protocols for recalcitrant and orthodox seeds; Cytological studies for assessing genetic stability, *in vitro* cultures- embryo, cell/suspension cultures, pollen cultures, study of cryotank facility and vitrification techniques, visit to NBPGR/NBAGR - study using fruit crops and other horticultural crops.
## DEPARTMENT OF HORTICULTURE

### List of Courses

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<th>Course No.</th>
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### B.Sc. (Ag.) Courses

#### Core Courses

- HOR-111  Production Technology of Fruit Crops                  3(2+1)
- HOR-121  Production Technology of Vegetables and Flowers        3(2+1)
- HOR-211  Production Technology of Spices, Aromatic, Medicinal and Plantation Crops  3(2+1)
- HOR-311  Post Harvest Management and Value Addition of Fruits and Vegetables  2(1+1)

### M.Sc. (Ag). Courses

- HOR 501* Tropical and Dry-land Fruit Production                3(2+1)
- HOR 502* Production Technology of Warm Season Vegetable Crops  3(2+1)
- HOR 503* Landscaping and Ornamental Gardening                  3(2+1)
- HOR 504* Breeding of Horticultural Crops                       3(2+1)
- HOR 505 Production Technology of Cool Season Vegetable Crops  3(2+1)
- HOR 506 Sub-tropical and Temperate Fruit Production            3(2+1)
- HOR 507 Post harvest Management of Horticultural Crops         3(2+1)
- HOR 508 Growth and Development of Horticultural Crops          3(2+1)
- HOR 509 Protected Floriculture                                 3(2+1)
- HOR 510 Canopy Management in Fruit Crops                       3(2+1)
- HOR 512 Production Technology of Cut Flowers                   3(2+1)
Ph. D. Courses

HOR 601** Advances in Breeding of Fruit and Plantation Crops 3(2+1)
HOR 602** Advances in Breeding of Vegetable Crops 3(2+1)
HOR 603 Advances in Production of Fruit Crops 3(2+1)
HOR 604 Advances in Production of Vegetable Crops 3(2+1)
HOR 605 Advances in Flower Production Technology 3(2+1)
HOR 606** Advances in Breeding of Flower Crops 3(2+1)
HOR 607 Biotic and Abiotic Stress Management in Horticultural Crops 3(2+1)
HOR 691** Doctoral Seminar – I (Synopsis Seminar) 1(1+0)
HOR 692** Doctoral Seminar – II (Course Seminar) 1(1+0)
HOR 699** Doctoral Research 45

B.Sc. (Ag.) Courses

HOR-111. Production Technology of Fruit Crops 3(2+1)


Practical: Identification of horticultural tools and implements and their uses; containers, potting mixture, potting, repotting and depotting; plant propagation, seed propagation, scarification, and stratification; propagation by cuttings (softwood, semi-
hardwood and hardwood), layering (simple layering, air layering and stooling in guava); orchard layout and planting systems (traditional and high density); Methods of training and pruning; training of ber, grape and pomegranate; pruning of ber, grape, phalsa, fig, apple, peach and pear; identification and description of varieties of mango, guava, grape, papaya, apple and sapota; identification and description of varieties of banana, citrus (lime, lemon, sweet orange, mandarin and grape fruit), pomegranate, bael, ber and pear; Irrigation methods including drip. Establishment of micro-irrigation system in orchard. Fertilizer application in fruit crops including fertigation. Visit to local commercial orchards; Preparation of growth regulators, powder, solution and lanolin paste for propagation; application of growth regulators for improving fruit set, fruit size, quality, delaying ripening and hastening ripening.

**HOR-121 Production Technology of Vegetables and Flowers**

Importance of Olericulture, vegetable gardens, vegetable classification. Origin, area, production, varieties, package of practices for fruit vegetables- tomato, brinjal, chillies and okra; Cucurbitaceous vegetables- cucumber, bottle gourd, bitter gourd and melons; Cole crops- cabbage and cauliflower; Bulb crops- onion and garlic; Beans and peas- French bean, dolichos beans and peas; Tuber crops- potato and sweet potato; Root crops- carrot and radish; Leafy vegetables- amaranthus and palak; Perennial vegetables- drumstick and coccinia. Importance of floriculture and ornamental gardens. Planning of ornamental gardens. Types and styles of ornamental gardens. Use of trees, shrubs, climbers, palms, foliage, succulents and seasonal flowers in the gardens. Package of practices for rose, jasmine, chrysanthemum, carnation, marigold, tuberose and gladiolus.

**Practical:** Planning and layout of kitchen garden; identification of important vegetable seeds and plants; raising of vegetable nurseries; identification of ornamental plants (trees, shrubs, climbers, foliage, succulents, palms etc.) and development of garden features; transplanting of vegetable seedlings; layout of lawns and maintenance; seed extraction in tomato and brinjal. Repotting and depotting and maintenance of ornamental plants; visit to commercial vegetable farms; training and pruning of rose (standards, hybrid “T” and scented) and chrysanthemum (pinching and disbudding); planning and layout of gardens and garden designs for public and private areas; intercultural operations in vegetable plots; seed production in vegetable crops; harvest indices of different vegetable crops; grading and packaging of vegetable; prolonging the vase life of cut flowers.

**HOR-211 Production Technology of Spices, Aromatic, Medicinal and Plantation Crops**

Importance and cultivation technology of spices - clove, ginger, turmeric, black pepper, cardamoms, nigella coriander, cumin, fenugreek; aromatic crops- lemon grass, citronella, palmarose, vetiver, geranium, dawana; plantation crops – coconut, arecanut, betelvine, cashew, cocoa, coffee, tea, oilpalm; medicinal plants- dioscoria, rauvolphaa, opium, ocimum, perwinkle, aloe, guggul, belladonna, nuxvomica, Solanum khasiamum, senna, plantago, stevia, coleus and acorus.

**Practical**

Botanical description and identification of medicinal and aromatic plants; identification of spices and plantation crops; propagation techniques in aromatic and spice crops; selection of mother palm and seed nuts in coconut and oil palm; distillation procedures for aromatic crops; propagation methods in plantation crops (tea and coffee); propagation and planting methods in turmeric, ginger and black pepper; harvesting procedures in aromatic plants; processing and curing of spices.
(ginger, turmeric and black pepper); training methods in betelvine. Rejuvenation practices in cashewnut; products- byproducts of spices and plantation crops; procedures for oleoresin extraction. Visit to local commercial plantations, aromatic and medicinal plant nurseries and seed spices field.

HOR-311 Post Harvest Management and Value Addition of Fruits and Vegetables 2(1+1)


Practical: Practice in judging the maturity of various fruits and vegetables. Conservation of zero energy cool chambers for on farm storage. Determination of physiological loss in weight (PLW), total soluble solids (TSS), total sugars, acidity and ascorbic acid content in fruits and vegetables. Packaging methods and types of packages and importance of ventilation. Precooling and methods of prolonging storage life. Effect of ethylene on ripening of banana, sapota and mango. Identification of equipment and machinery used is preservation of fruits and vegetables. Preservation by drying and dehydration. Preparation of jam, jelly, marmalades, squash and syrups. Preparation of chutneys, pickles, sauces and ketchup. Visit to local processing units, local market yards, cold storage units and packaging industries.

M.Sc. (Ag). Courses

HOR 501 Tropical And Dry Land Fruit Production 3(2+1)

Theory

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

UNIT I: Mango and Banana
UNIT II: Citrus and Papaya
UNIT III: Guava, Sapota and Jackfruit
UNIT IV: Pineapple, Annonas, Avocado and Bael
UNIT V: Aonla, Pomegranate, Phalsa and Ber

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing of commercial orchards.

HOR 502 Production Technology Of Warm Season Vegetable Crops 3(2+1)

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, plant protection measures, and seed production of:

UNIT I
Tomato, eggplant, hot and sweet peppers

UNIT II
Okra, beans, cowpea and cluster bean

UNIT III
Cucurbitaceous crops

UNIT IV
Tapioca and sweet potato

UNIT V
Green leafy warm season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments
to demonstrate the role of mineral elements, physiological disorders; plant growth regulators and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Suggested Readings

HOR 503 Landscaping And Ornamental Gardening 3(2+1)

Theory

UNIT I
Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II
Urban landscaping, Landscaping for specific situations, institutions, industries, residences, hospitals, roadsides, traffic islands, dam sites, IT parks, corporate offices.

UNIT III
Garden plant components, arboretum, shrubbery, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers; Production technology for selected annual ornamental plants.

UNIT IV
Lawns, establishment and maintenance of vertical garden, roof garden, bog garden, sunken garden, rock garden.

UNIT V
Bio-aesthetic planning, eco-tourism, indoor gardening, xeri-scaping, hard-scaping.

Practical

Identification and selection of ornamental plants for landscaping, practices in preparing designs for home gardens, institutional gardens, avenue planting, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

HOR 504 Breeding of Horticultural Crops 3(2+1)

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

Crops

UNIT I: Mango, banana, papaya and grapes

UNIT II: Citrus and apple

UNIT III: Potato, tomato and brinjal

UNIT IV: Hot & Sweet pepper, okra, cabbage and cauliflower

UNIT V: Rose, chrysanthemum, gladiolus and dahlia

Practical

Characterization of germplasm, blossom biology, study of anthesis, selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, palaeoanological studies, selfing and crossing techniques in horticultural crops; hybrid seed production of horticultural crops in bulk. Screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population; Visit to breeding blocks.


Paroda RS & Kalloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region*. FAO.


Ray PK. *Fruit Breeding*. Narasa Publ.


HOR 505 Production Technology of Cool Season Vegetable Crops 3(2+1)

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I
Potato

UNIT II
Cole crops: cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels sprout

UNIT III
Root crops: carrot, radish, turnip and beetroot

UNIT IV
Bulb crops: onion and garlic

UNIT V
Peas and freanch bean, cool season green leafy vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth regulators and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.


HOR 506 Subtropical And Temperate Fruit Production 3(2+1)

Theory
Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bio-regulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-symptoms, causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, pre-cooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support.

Crops

UNIT I: Apple, pear and grapes

UNIT II: Plums, peach, apricot and cherries,

UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT IV: Nuts- walnut and almond

UNIT V: Minor fruits- mangosteen, carambola, bael, fig and jamun

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

HOR 507 Post Harvest Management Of Horticultural Crops

3(2+1)

Theory

UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration and transpiration.

UNIT II

Physiology and biochemistry of ripening and senescence, ethylene evolution and ethylene management, factors leading to post-harvest loss and pre-cooling.

UNIT III

Treatments prior to shipment, viz., chlorination, waxing, chemicals, bio-control agents and natural plant products. Methods of storage, ventilated, refrigerated, MAP, CA storage, zero energy cool chamber, hypobaric storage, spoilage: microbial and bio-chemical, physical injuries and storage disorders.

UNIT IV

Packing methods and transport, principles and methods of preservation, processing and canning. Preparation of fruit juices, beverages, pickles, jam, jellies, candies and tomato products. Value addition and post harvest management of loose and cut flowers.

UNIT V
Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, management of processing wastes and food safety standards.

**Practical**

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

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HOR 508  **Growth And Development of Horticultural Crops**  
3(2+1)

**Theory**

UNIT I

Cellular structures and their functions; definition of growth and development, growth analysis and its importance in horticultural crops.

UNIT II

Physiology of dormancy and germination of seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscissic acid; Application of plant growth regulators, plant growth retardants and inhibitors for various purposes in horticultural crops; Role and mode of action of morphactins, anti-transpirants, anti-auxin, ripening retardant and plant stimulants in horticultural crop.

UNIT III

Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in horticultural crops; apical dominance.

**Practical**

Preparation of solutions of plant growth regulators and their application; experiments in induction and breaking of dormancy by chemicals; induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, sex modification, reduce flower and fruit drops and improving fruit set in horticultural crops.

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HOR 509  **Protected Cultivation of Horticultural Crops**  
3(2 + 1)

**Theory**

UNIT I
Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade nets, rain shelters etc. Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable crops for protected cultivation: Strawberry, capsicum, tomato, cucumber, rose, gerbera and carnation.

UNIT II
Environment control – management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III
Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV
Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, de-shooting, de-blossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V
Harvest indices for domestic and export market: harvesting techniques.

Practical
Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, post-harvest handling, packing methods, project preparation, visit to commercial greenhouses.

HOR 510 Canopy Management In Fruit Crops 2(1+1)

Objective
To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory
UNIT I
Canopy management - importance and advantages; factors affecting canopy development.

UNIT II
Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

UNIT III
Spacing and utilization of land area; Canopy management through rootstock and scion, training and pruning and management practices.

UNIT IV

Canopy development and management in relation to growth, flowering, fruiting and fruit quality in apple, peach, pear, grapes, mango, sapota, guava and ber.

Practical

Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

HOR 511 Systematics of Vegetable Crops  
2(1+1)

Theory

UNIT I

Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops.

UNIT II

Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering summer vegetables (tomato, brinjal, chilli and cucumber) and winter vegetables (cauliflower, cabbage, peas and beans).

UNIT III

Cytology and descriptive keys of above vegetables.

UNIT IV

Molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description, classification and maintenance of vegetable species and varieties; survey, collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

HOR 512 Production Technologies of Cut Flowers  
3(2+1)

Theory

UNIT I

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

UNIT II
Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT III

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, dahlia, gypsophilla, statice, cut foliages and fillers.

Practical

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

HOR 513 Production Technologies For Medicinal And Aromatic Crops

Objective

To impart comprehensive knowledge about the production technology of medicinal and aromatic crops.

Theory

UNIT I

Export and import status, Indian system of use of medicinal plant, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production.

UNIT II

Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, Dioscorea sp., Aloe vera, Andrographis paniculata.

UNIT III

Production technology for Isabgol, Poppy, Safed musli, Stevia rebaudiana, Ocimum sp.

UNIT IV

Post harvest handling of above mentioned medicinal plants and herbal products and phytochemical extraction techniques.

UNIT V

Aromatic industry, Indian perfumery industry, History, Advancements in perfume industry.

UNIT VI
Production technology for palmarosa, lemongrass, citronella, geranium, artemisia, mentha, patchouli, lavender.

UNIT VII

Post-harvest handling of above mentioned aromatic crops.

Practical

Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Visit to herbal extraction units. Extraction of Essential oils, Project preparation for commercially important aromatic crops, Visit to distillation and value addition units.

Ph. D. Courses

HOR 601  Advances In Breeding of Fruit And Plantation Crops 3(2+1)

Theory

Introduction, adaptation and domestication, Genetic resources, cytogenetics, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility and sterility systems in fruits, recent advances in crop improvement efforts- introduction and selection, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, modern approaches in improvement of fruit crops.

Crops

UNIT I: Mango and banana
UNIT II: Papaya and grapes
UNIT III: Guava and sapota
UNIT IV: Cashew nut and coconut
UNIT V: Apple and pear

Practical

Description and cataloguing of germplasm, pollen viability tests, pollen germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagens and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques.

HOR 602  Advances In Breeding of Vegetable Crops 3(2+1)

Theory
Evolution, distribution, cytogenetics, genetic resources, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, ideo type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, \textit{in vitro} breeding; breeding techniques for improving quality; breeding for biotic and abiotic stresses of:

**UNIT I**
Tomato, brinjal, chilli and potato

**UNIT II**
Cucumber, Cabbage, cauliflower and melons

**UNIT III**
Okra, onion, peas and beans

**UNIT IV**
Carrot and radish

**UNIT V**
Sweetpotato, elephant foot and yam

**Practical**
Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease resistance, estimation of quality and processing characters, screening for-quality improvement, estimation of heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

**HOR 603 Advances In Production of Fruit And Plantation Crops** 3(2+1)

**Theory**
National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Total quality management(TQM):

**Crops**
UNIT I : Mango and banana
UNIT II: Papaya, grapes and citrus
UNIT III: Guava, pomegranate and litchi
UNIT IV: Pineapple, cashew nut and coconut
UNIT V: Apple, pear and peach
Practical
Survey of cropping systems and development of high density orchard, Estimating nutrient deficiency- modern methods of irrigation and quality analysis of fruits, use of plant growth regulators and micro-nutrient in plant growth regulation

HOR 604 Advances In Vegetable Production
Theory
Present status and prospects of integrated vegetable cultivation; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic and inorganic sources of nutrients and management of different cropping systems; containerized culture, year round vegetable production; low cost polyhouse; net house production; organic gardening; vegetable production for nutraceutical, export and processing of:

UNIT I
Tomato, brinjal, chilli and potato

UNIT II
Cucumber, melons, cabbage and cauliflower

UNIT III
Okra, onion, peas and beans

UNIT IV
Carrot, beet root and radish

UNIT V
Sweet potato and tapioca

Practical
Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; diagnosis of nutritional and physiological disorders; use of plant growth regulators; practices in herbicide application; maturity indices; quality analysis; marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

HOR 605 Advances In Flower Production Technology
Theory
UNIT I
Commercial flower production; importance and scope; Global Scenario in cut flower production and trade, Standards for nutritional and global trends, cut flower, loose flowers, dry flowers and floral oil trade.

UNIT II
IPR issues related to planting materials; Greenhouse cultivation techniques; influence of environmental parameters, light, temperature, moisture and CO2 on growth and flowering; regulation for quality flowers.

UNIT III
Harvest indices; Harvesting techniques; Post-harvest handling; Export potential; Agri Export Zones.

UNIT IV
Advance practices in crops like rose, anthurium, orchids, carnation, gerbera, lilies, bird of paradise, Jasminum sp.

UNIT V
Floral oil industry, floral concrete production, extraction methods in crops like rose, tuberose, jasminum.

Practical
Greenhouse management; Soil decontamination; Microirrigation; fertigation. Special practices- Pinching, netting, disbudding, defoliation and chemical pruning; Photoperiodic and chemical induction of flowering; Post-harvest handling; Preparation of floral decoratives; visit to commercial cut flower units and extraction units.

HOR 606 Advances In Breeding of Flower Crops 3(2+1)

Objective
To update knowledge on the recent research trends in the field of breeding of flower crops with special emphasis on crops grown in India.

Theory
UNIT I
Origin of flower crops, Genetic resources, improvement by introduction, selection, and hybridization, Inheritance of important characters, Genetic mechanisms associated with flower colour and flower size, doubleness, fragrance and post-harvest life.

UNIT II
Specific objectives of breeding in flower crops, Methods of breeding suited to seed and vegetatively propagated flower crops, Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility-Incompatibility problems, Invitro breeding.

UNIT III
Breeding for resistance to biotic and abiotic stresses in flower crops.

UNIT IV
Specific breeding problems and achievements made in rose, jasmine, chrysanthemum, marigold, tuberose, dahlia gladioli, orchids and aster.

**Practical**

Identification of crops and commercial cultivars; floral biology, selfing and crossing, Induction of mutants using physical and chemical mutagens; Induction of polyploidy; Screening of plants for biotic and abiotic stresses.

**HOR 607 Biotic And Abiotic Stress Management In Horticultural Crops**  
3(2+1)

**Theory**

UNIT I

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, pollution - increased level of CO2, industrial wastes, ion toxicity, heavy metals).

UNIT II

Impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations, assessing the stress through remote sensing.

UNIT III

Greenhouse effect and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mulching, hydrophilic polymers, mode of action and practical use, HSP inducers in stress management.

UNIT IV

Rain water harvesting, increasing water use efficiency, IPM & IDM, use of biocontrol and botanical bioagents.

**Practical**

Seed treatment, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), chlorophyll, chlorophyll stability index, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, use of anti-transpirant, mulching, bio-control agents, visit to orchards and water shed locations.
## DEPARTMENT OF MYCOLOGY AND PLANT PATHOLOGY

### List of Courses

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<td>(Theory + Practical)</td>
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### B.Sc. (Ag.) Courses

#### Core Courses

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<th>Credit Hours</th>
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<tr>
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<td>Plant Pathogens and Principals of Plant Pathology</td>
<td>4(3+1)</td>
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<tr>
<td>MPP-121</td>
<td>Agricultural Microbiology</td>
<td>3(2+1)</td>
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<tr>
<td>MPP-221</td>
<td>Diseases of Field Crops and their Management</td>
<td>3(2+1)</td>
</tr>
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<td>MPP-311</td>
<td>Diseases of Horticultural Crops and their Management</td>
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### M.Sc. (Ag.) Courses

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<tr>
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<tr>
<td>MPP 502*</td>
<td>PLANT VIROLOGY</td>
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<td>MPP 503*</td>
<td>PLANT BACTERIOLOGY</td>
<td>3(2+1)</td>
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<tr>
<td>MPP 504*</td>
<td>PRINCIPLES OF PLANT PATHOLOGY</td>
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<td>MPP 505*</td>
<td>DETECTION AND DIAGNOSIS OF PLANT DISEASES</td>
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<td>MPP 506*</td>
<td>PRINCIPLES OF PLANT DISEASE MANAGEMENT</td>
<td>3(2+1)</td>
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<td>MYCOLOGY</td>
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<td>MPP 503*</td>
<td>PLANT BACTERIOLOGY</td>
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<td>MPP 507</td>
<td>DISEASES OF FIELD AND MEDICINAL CROPS</td>
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<td>MPP 508</td>
<td>DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS</td>
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<td>MPP 509</td>
<td>DISEASES OF VEGETABLE AND SPICES CROPS</td>
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<td>MPP 510</td>
<td>SEED HEALTH TECHNOLOGY</td>
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<tr>
<td>MPP 511</td>
<td>CHEMICALS IN PLANT DISEASE MANAGEMENT</td>
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<tr>
<td>MPP 512</td>
<td>ECOLOGY OF SOIL-BORNE PLANT PATHOGENS</td>
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<tr>
<td>MPP 513</td>
<td>DISEASE RESISTANCE IN PLANTS</td>
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<tr>
<td>MPP 514/ENT 514</td>
<td>INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS</td>
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<tr>
<td>MPP 515</td>
<td>BIOLOGICAL CONTROL OF PLANT DISEASES</td>
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<td>MPP 517</td>
<td>MUSHROOM PRODUCTION TECHNOLOGY</td>
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<td>MPP 518</td>
<td>EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES</td>
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<td>MPP 591*</td>
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**Ph.D. Courses**

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<td>MPP 601**</td>
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<td>MPP 602</td>
<td>ADVANCED VIROLOGY</td>
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<td>MPP 603</td>
<td>ADVANCED BACTERIOLOGY</td>
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<td>MPP 604**</td>
<td>MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION</td>
<td>3(2+1)</td>
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<td>PRINCIPLES AND PROCEDURES OF CERTIFICATION</td>
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<td>PLANT BIOSECURITY AND BIOSAFETY</td>
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<td>MPP 699**</td>
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B.Sc. (Ag.) Courses

MPP – 111  Plant Pathogens and Principles of Plant Pathology  4 ( 3 + 1)


Practical: Acquaintance to plant pathology laboratory and equipments; Preparation of culture media for fungi and bacteria; Isolation techniques, preservation of disease samples; Study of Pythium, Phytophthora and Albugo; Study of Sclerospora, Peronosclerospora, Pseudoperonospora, Peronospora, Plasmopara and Bremia: Study of genera Mucor and Rhizopus. Study of Oidium, Oidiopsis, Ovulariopsis, Erysiphe, Phyllactinia, Uncinula and Podosphaera; Study of Puccinia (different stages), Uromyces, Study of Sphacelotheca, Ustilago and Tolyposporium ; Study of Agaricus, Pleurotus and Ganoderma; Study of Septoria, Colletotrichum, Pestalotiopsis and Pyricularia; Study of Aspergillus, Penicillium, Trichoderma, and Fusarium; Study of Drechslera, Alternaria, Stemphyllium, Cercospora, Phaeoisariopsis, Rhizoctonia and Sclerotium, Demonstration of Koch’s postulates; Study of different groups of fungicides and antibiotics; Preparation of fungicides – Bordeaux mixture, Bordeaux paste, Chestnut compound; Methods of application of fungicides- seed, soil and foliar; Bio-assay of fungicides – poisoned food technique, inhibition zone technique and slide germination technique; Bio-control of plant pathogens – dual culture technique, seed treatment . Visit to quarantine station and remote sensing laboratory.

MPP-121 Agricultural Microbiology  3(2+1)


MPP-221 Diseases of Field Crops and Their Management 3(2+1)

Economic importance, symptoms, cause, epidemiology, disease cycle and integrated management of diseases of rice, sorghum, bajra, maize, wheat, sugarcane, turmeric, tobacco, groundnut, sesamum, sunflower, cotton, redgram, bengalgram, blackgram, greengram, tea, soybean.

Practical: Study of symptoms, etiology, host-parasite relationship and specific control measures of the following crop diseases. Preservation of disease samples, survey and collection of Diseases of rice, sorghum; Diseases of wheat , bajra, & maize; Diseases of sugarcane, turmeric & tobacco; Diseases of groundnut, castor & sunflower ; Diseases of sesame & cotton ; Diseases of redgram, greengram, blackgram, bengalgram & beans; Field visits at appropriate time during the semester.

Note: Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester.

MPP-311 Diseases of Horticultural Crops and Their Management 3(2+1)

Economic Importance, symptoms, cause, disease cycle and integrated management of diseases of: citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, apple, chilli, brinjal, bhendi, potato, crucifers, cucurbits, tomato, beans, onion, coconut, oil palm, betelvine, mulberry, coffee, tea, rose, chrysanthemum and jasmine.

Practical: Diseases of beans, phaseolus, soyabeans, fababean, Urd and mung, citrus, guava, and sapota; Diseases of papaya, banana, pomegranate & ber; Diseases of mango, grape & apple; Diseases of chilli, brinjal & Bhendi; Diseases of potato, tomato & crucifers; Diseases of cucurbits, onion & betelvine; Diseases of oil palm, coconut, tea, coffee & mulberry; Diseases of rose, chrysanthemum and jasmine. Field visits at appropriate time during the semester.
M.Sc. (Ag). Courses

MPP -501  Mycology  3(2+1)

Theory
UNIT I
Introduction, definition of different terms, basic concepts.
UNIT II
Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology.
UNIT III
Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.
UNIT IV
The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens: types and importance, fungal genetics and variability in fungi.

Practical
Detailed comparative study of different groups of fungi; collection, identification and preservation of specimens. Isolation and identification of plant pathogenic fungi.

MPP-502  Plant Virology  3(2+1)

Theory
UNIT I History of plant viruses, composition and structure of viruses.
UNIT II Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host-virus interaction, virus-vector relationship.
UNIT III Virus nomenclature and classification, genome organization, replication and movement of viruses.
UNIT IV Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.
UNIT V Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome.
UNIT VI Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

Practical
Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, purification, method of raising antisera, serological tests, electron microscopy and ultratomy, PCR.
MPP-503  Plant Bacteriology  3(2+1)

Theory
UNIT I History and introduction to phytopathogenic prokarya, viz., bacteria, MLOs, spiroplasmas and other fastidious prokarya. Importance of phytopathogenic bacteria.
UNIT II Evolution, classification and nomenclature of phytopathogenic prokarya and important diseases caused by them.
UNIT III Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic prokarya.
UNIT IV General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios.
UNIT V Prokaryotic inhibitors and their mode of action against phytopathogenic bacteria.
UNIT VI Survival and dissemination of phytopathogenic bacteria.

Practical
Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical and serological characterization, isolation of plasmid and use of antibacterial chemicals/antibiotics.

MPP-504  Principles of Plant Pathology  3(3+0)

Theory
UNIT I Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.
UNIT II Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.
UNIT III Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.
UNIT IV Genetics of resistance; ‘R’ genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.
UNIT V Disease management strategies.

MPP-505  Detection And Diagnosis of Plant Diseases  2(0+2)

Practical
UNIT I Methods to prove Koch’s postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.
UNIT II Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.
UNIT III Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron
microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides, etc.; field experiments, data collection and preparation of references.

MPP-506  Principles of Plant Disease Management  3(2+1)

Theory
UNIT I Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanical methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management.
UNIT II Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.
UNIT III History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

Practical
In vitro and in vivo evaluation of chemicals against plant pathogens; ED and MIC values, study of structural details of sprayers and dusters.

MPP-507  Diseases of Field And Medicinal Crops  3(2+1)

Theory
UNIT I Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize.
UNIT II Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean.
UNIT III Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.
UNIT IV Diseases of Cash crops- cotton, sugarcane.
UNIT V Diseases of Fodder legume crops- berseem, oats, guar, lucerne, cowpea.
UNIT VI Medicinal crops- plantago, liquorice, mullathi, rosagrass, sacred basil, mentha, ashwagandha, Aloe vera.

Practical
Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops.

MPP-508  Diseases of Fruits, Plantation And Ornamental Crops  3(2+1)
Theory
UNIT I Introduction, symptoms and etiology of different fruit diseases. Factors affecting disease development in fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond, strawberry, citrus, mango, grapes, guava, ber, banana, pineapple, papaya, fig, pomegranate, date palm and management of the fruits diseases.
UNIT II Symptoms, mode of perpetuation of diseases of plantation crops such as tea, coffee, rubber and coconut and their management.
UNIT III Symptoms and life cycle of pathogens. Factors affecting disease development of ornamental plants such as roses, gladiolus, tulip, carnation, orchids, marigold, chrysanthemum and their management.

Practical
Detailed study of symptoms and host parasite relationship of representative diseases of plantation crops. Collection and dry preservation of diseased specimens of important crops.

MPP-509 Diseases of Vegetable And Spices Crops 3(2+1)

Theory
UNIT II Symptoms and management of diseases of different root, bulb, leafy vegetables, crucifers, cucurbits and solanaceous vegetable crops.
UNIT III Symptoms, epidemiology and management of diseases of different spice crops such as black pepper, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger.

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

MPP-510 Seed Health Technology 3(2+1)

Theory
UNIT I History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.
UNIT II Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.
UNIT III Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.
UNIT IV Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.
Practical
Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses. Relationship between seed-borne infection and expression of the disease in the field.

MPP-511 Chemicals In Plant Disease Management 3(2+1)

Theory
UNIT I
History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals.
UNIT II
Classification of chemicals used in plant disease control and their characteristics.
UNIT III
Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals.
UNIT IV
Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of fungicides.
UNIT V
Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides.
UNIT VI
General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.

Practical
Acquaintance with formulation of different fungicides and plant protection appliances. Formulation of fungicides, bactericides and nematicides; in vitro evaluation techniques, preparation of different concentrations of chemicals including botanical pesticides based on active ingredients against pathogens; persistence, compatibility with other agro-chemicals; detection of naturally occurring fungicide resistant mutants of pathogen; methods of application of chemicals.

MPP-512 Ecology of Soil-Borne Plant Pathogens 3(2+1)

Theory
UNIT I Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi. Types of biocontrol agents. UNIT II Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis.
UNIT III Suppressive soils, biological control concepts and potentialities for managing soil borne pathogens.

Practical
Quantification of rhizosphere and rhizoplane microflora with special emphasis on pathogens; pathogenicity test by soil and root inoculation techniques, correlation between inoculum density of test pathogens and disease incidence, demonstration of fungistasis in natural soils; suppression of test soil-borne pathogens by antagonistic
microorganisms. Isolation and identification of different biocontrol agents.

**MPP-513  Disease Resistance In Plants  2(2+0)**

**Theory**
**UNIT I**
Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminology.

**UNIT II**
Disease escapes, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

**UNIT III**
Host defence system, morphological and anatomical resistance, preformed chemicals in host defence, post-infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms.

**UNIT IV**
Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

**MPP-514/ENT-514  Insect Vectors of Plant Viruses And Other Pathogens  2(1+1)**

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

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

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

**UNIT IV** Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

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

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

**MPP-515  Biological Control of Plant Diseases  3(2+1)**

**Theory**
**UNIT I** Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

**UNIT II** Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

**UNIT III** Factors governing biological control, role of physical environment, agroecosystem, operational
mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases. Compatibility of different bioagents.

UNIT IV Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.

Practical
Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, application of antagonists against pathogen in vitro & in vivo conditions. Study of cfu/g.

MPP-516       Integrated Disease Management       3(2+1)

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

MPP-517       Mushroom Production Technology       3(2+1)

Theory
UNIT I Historical development of mushroom cultivation and present status, taxonomy, classification, food, medicinal value, uses of mushroom, edible and poisonous mushrooms.
UNIT II Life cycle of cultivated mushrooms, reproduction and strain improvement, maintenance of pure culture, preparation of spawn and facilities required for establishing commercial spawn lab.
UNIT III Preparation of substrate for mushroom cultivation, long, short and indoor composting methods, formulae for different composts and their computation, qualities and testing of compost, uses of spent mushroom compost/substrate.
UNIT IV Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO₂, ventilation in cropping rooms, cultivation technology of Agaricus bisporus, Pleurotus sp., Calocybe indica, Lentinus edodes and Ganoderma lucidum.
UNIT V Insect pests, diseases and abnormalities of cultivated mushroom and their management, post harvest processing and value addition, economics of mushroom cultivation, biotechnology and mushroom cultivation.
Practical
Preparation of spawn, compost, spawning, casing, harvesting and postharvest handling of edible mushroom; identification of various pathogens, competitors of various mushroom.

MPP-518 Epidemiology And Forecasting of Plant Diseases 3(2+1)

Theory
UNIT I Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis.
UNIT II Common and natural logarithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.
UNIT III Survey, surveillance and vigilance, crop loss assessment and models.
UNIT IV Principles and pre-requisites of forecasting, systems and factors affecting various components of forecasts, some early forecasting, procedures based on weather and inoculum potential, modeling disease growth and disease prediction.

Practical
Measuring diseases, spore dispersal and trapping, weather recording, survey, multiplication of inoculum, computerized data analysis, function fitting, model preparation and validation.

MPP-519 Post Harvest Diseases 3(2+1)

Theory
UNIT I Concept of post harvest diseases, definitions, importance with reference to environment and health, principles of plant disease management as pre-harvest and post-harvest, merits and demerits of biological/phytoextracts in controlling post-harvest diseases.
UNIT II Types of post harvest problems both by biotic and abiotic causes, rhizosphere colonization, competitive, saprophytic ability, antibiosis, induced resistance, microbial associations, concept, operational mechanisms and its relevance in control.
UNIT III Factors governing post harvest problems both as biotic and abiotic, role of physical environment, agro-ecosystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens, pathogens and antagonist and their relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases, comparative approaches to control of plant pathogens by resident and introduced antagonists. Isolation, characterization and maintenance of pathogens, role of different storage conditions.
UNIT IV Integrated approach in controlling diseases and improving the shelf life of produce, control of aflatoxigenic and mycotoxigenic fungi, application and monitoring for any health hazard, knowledge of Codex Alimentarius for each product and commodity.

Practical
Isolation, characterization and maintenance of pathogens, role of different storage conditions on disease development, application of antagonists against pathogens in vivo and in vitro conditions. Comparative efficacy of
different chemicals, fungicides, phytoextracts and bioagents.

MPP-520 / ENT-520  Plant Quarantine  2(2+0)

Theory
UNIT I Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.
UNIT III Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfection/salvaging of infected material.
UNIT IV WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Ph.D. Courses

MPP-601  Advanced Mycology  (2+1)

Theory
UNIT I General introduction, historical development and advances in mycology.
UNIT II Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical (Computer based assessment) taxonomy.
UNIT III Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti. Morphology and reproduction of representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi.
UNIT IV Population biology, pathogenic variability/vegetative compatibility.

Practical

MPP-602  Advanced Virology  3(2+1)

Theory
UNIT I Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains.
UNIT II Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction.

UNIT III Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty-, bromo, cucummo, ilar and tospoviruses.

UNIT IV Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.

UNIT V Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants.

UNIT VI Techniques and application of tissue culture. Origin, evolution and interrelationship with animal viruses.

Practical
Purification of virus(es), SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS-ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for collecting vectors and their maintenance, nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing, annotation of genes.

MPP-603 Advanced Bacteriology 3(2+1)

Theory

UNIT II Current trends in taxonomy of phytopathogenic prokarya.

UNIT III Role of enzyme, toxin, expolysaccharide, polypeptide signals in disease development. Mechanism of wilt (Ralstonia solanacearum) development, mechanism of soft rot (Erwinia spp.) development, mechanism of Crown gall formation (Agrobacterium tumifaciens).

UNIT IV Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.

UNIT V Molecular variability among phytopathogenic prokarya and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pathogens-gene silencing, RNAi technology.

UNIT VI Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit.

UNIT VII Beneficial prokaryaotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Practical
Pathogenic studies and race identification; plasmid profiling of bacteria; fatty acid profiling of bacteria; RAPD profiling of bacteria and variability status; Endospore, Flagella staining; test for secondary metabolite production, cyanides, EPS, siderophore; specific detection of phytopathogenic bacteria using species/pathovar specific primers. Basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts.
Theory

UNIT I Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship.

UNIT II Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.


UNIT IV Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

UNIT V Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.
Practical
Protein, DNA and RNA isolation, Plasmid extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

MPP-605  Principles And Procedures of Certification  1(1+0)

Theory
UNIT I  Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD, etc. in certification and quality control.
UNIT II  Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health, etc.
UNIT III  Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative propagules and in vitro cultures. Accreditation of seed testing laboratories. Role of seed/planting material health certification in national and international trade.

MPP-606  Plant Biosecurity And Biosafety  2(2+0)

Theory
UNIT I  History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.
UNIT II  National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.
## DEPARTMENT OF PLANT PHYSIOLOGY

### List of Courses

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<td>(Theory + Practical)</td>
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<tr>
<td><strong>B.Sc. (Ag.) Courses</strong></td>
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<tr>
<td>PPH-111</td>
<td>Crop Physiology</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>PPH-221</td>
<td>Environmental Science</td>
<td>2(1+1)</td>
</tr>
<tr>
<td>PPH-321</td>
<td>Applied Plant Physiology</td>
<td>1(1+1)</td>
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<tr>
<td><strong>M.Sc. (Ag.) Courses</strong></td>
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<td></td>
<td><strong>Core Courses</strong></td>
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<tr>
<td>PPH 501</td>
<td>Principles of Plant Physiology</td>
<td>4(3+1)</td>
</tr>
<tr>
<td>PPH 502</td>
<td>Plant Developmental Biology-Physiological and Molecular Basis</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>PPH 503</td>
<td>Physiological and Molecular Responses of plants to Abiotic Stresses</td>
<td>3(2+1)</td>
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<tr>
<td>PPH 504</td>
<td>Hormonal Regulation of Plant Growth and Development</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>PPH 506</td>
<td>Physiology of Growth and Yield and Modeling</td>
<td>2(1+1)</td>
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<tr>
<td>PPH 508</td>
<td>Morphogenesis, Tissue Culture and Transformation</td>
<td>3(2+1)</td>
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<td><strong>Optional Courses</strong></td>
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<tr>
<td>PPH 507</td>
<td>Genome Organization In Higher Plants</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>PPH 509</td>
<td>Physiology of Crop Plants –Specific Case Studies</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>PPH 510</td>
<td>Physiological And Molecular Aspects of Photosynthesis – Carbon and Nitrogen Assimilation</td>
<td>3(2+1)</td>
</tr>
<tr>
<td>PPH 511</td>
<td>Mineral Nutrition</td>
<td>3(2+1)</td>
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<tr>
<td>PPH 550</td>
<td>MASTER’S SEMINAR</td>
<td>1(1+0)</td>
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<tr>
<td>PPH 560</td>
<td>MASTER’S RESEARCH</td>
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# Ph.D. Courses

## Core Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PPH 601</td>
<td>Functional genomics and genes associated with a few physiological processes</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>PPH 602</td>
<td>Signal Perceptions And Transduction And Regulation Of Physiological Processes</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>PPH 603</td>
<td>Molecular approaches for improving physiological traits</td>
<td>3(2+1)</td>
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## Optional Courses

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>PPH 604</td>
<td>Techniques In Plant Physiology</td>
<td>3(1+2)</td>
</tr>
<tr>
<td>PPH 605</td>
<td>Climate Change And Crop Growth</td>
<td>2(2+0)</td>
</tr>
<tr>
<td>PPH 606</td>
<td>Post Harvest Physiology</td>
<td>3(2+1)</td>
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<tr>
<td>PPH 607</td>
<td>Weed Physiology And Herbicide Action</td>
<td>2(1+1)</td>
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<tr>
<td>PPH 608</td>
<td>Seed Physiology</td>
<td>3(2+1)</td>
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## Doctoral Seminar and Research

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<tr>
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<td>PPH 650</td>
<td>DOCTORAL SEMINAR</td>
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<tr>
<td>PPH 660</td>
<td>DOCTORAL RESEARCH</td>
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<tr>
<td>PPH 651</td>
<td>Research Plan Proposal Seminar</td>
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<tr>
<td>PPH 652</td>
<td>Pre-Submission Ph.D. Thesis Seminar</td>
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# B.Sc. (Ag.) Courses

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>PPH-111</td>
<td>Crop Physiology</td>
<td>3 (2+1)</td>
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</table>

Introduction, Importance in Agriculture. Seed Physiology, Seed structures, Morphological, physiological and biochemical changes during seed development, Physiological maturity Morphological and physiological changes associated with physiological maturity in crop, Harvestable maturity, Seed viability and vigour, Factors affecting seed viability and vigour. Methods of testing seed viability and vigour, Germination, Utilization of seed reserves during seed germination, Morphological, physiological and biochemical changes during seed germination, Factors affecting seed germination. Growth and Development, Definition, Determinate and Indeterminate growth, Monocarpic and Polycarpic species with examples. Measurement of growth, Growth analysis, Growth characteristics, Definitions and mathematical formulae.

Practical
Preparation of solutions; Growth analysis: Calculation of growth parameters; Methods of measuring water status in roots, stems and leaves; Measurement of water potential by Chardakov’s method; Measurement of absorption spectrum of chloroplastic pigments and fluorescence; Measurement of leaf area by various methods; Stomatal frequency and index – Respirometer-Measurement of respirometer; leaf anatomy of C₃ and C₄ plants; Measurement of Transpiration; Imbibition of seed; Optimum conditions for seed germination; Breaking seed dormancy; (a) Chemical method (b) Mechanical method; Yield analysis; Seed viability and vigour tests; Effect of ethylene on regulation of stomata.

PPH-221 Environmental Science 2(1+1)


Practical
Collection, processing and storage of effluent samples; Determination of Biochemical oxygen demand (BOD) in effluent sample; Determination of chemical oxygen demand (COD) in effluent sample; Estimation of dissolved oxygen in effluent samples; Determination of sound level by using sound level meter; Estimation of respirable and non respirable dust in the air by using portable dust sampler; Determination of total dissolved solids (TDS) in effluent samples; Estimation of species abundance of plants; Estimation of nitrate contamination in ground water; Analysis of temporary and total hardness of water sample by titration; Estimation of pesticide contamination in Agro-Ecosystem; Visit to Social Service Organization / Environmental Education Centre; Crop adaptation to environmental variables, soils conditions; Study of
transpiration and water balance in plants; Visit to a local polluted site. Observations and remedial measures; Assessment of chlorophyll content of fresh water / sea water ecosystem.

**PPH-321**  Applied Plant Physiology  3 (2+1)

**Physiological basis of yield:** External and internal factors controlling photosynthetic productivity and photo respiratory losses, Partitioning of photosynthate and its regulation by mineral nutrients and phytohormones with reference to economic yield, Physiological maturity and harvest index, Flower shedding and pod drop in legumes, Boll shedding in cotton. **Signal transduction:** Sugar and nitrate signaling, ABA signal transduction, Role of calcium and calmodulin in signal transduction. **Practical aspects of hydroponics:** Advantages and disadvantages, foliar nutrition. Applications of **plant tissue culture** in agriculture, horticulture and forestry. Practical applications of **seed priming** in agriculture. Economics of **biological N; fixation**, Nitrogen assimilation. **Allelopathic** effects of crops. **Post harvest physiology:** Physiological principles of storage of seeds and fruits, biochemical changes during post harvest storage of fruits, physiology of seed and fruit maturation, molecular basis of senescence and fruit ripening.

Practical: Leaf area determination by conventional methods, Harvest index, Preparation of balanced nutrient solution, Sand washing, Set up of soil-less culture to diagnose deficiency of mineral elements, Seed viability test, Seed priming, Aseptic techniques and preparation of nutrient media for plant tissue culture, Study of biochemical changes during senescence of plant parts: Estimation of sugars and proteins.

**M.Sc. (Ag.) Courses**

**PPH 501**  Principles of Plant Physiology  4(3+1)

**Theory**

**UNIT I**

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions.

**UNIT II**

Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells.

**UNIT III**

Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorhizal association on water uptake.
UNIT IV

UNIT V
Stomata structure and function – mechanism of stomatal movement, antitranspirants.

UNIT VI

UNIT VII
The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants.

UNIT VIII
Uptake of mineral elements in plants –Mechanisms of uptake-translocation of minerals in plants.

UNIT IX
Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar nutrition.

UNIT X

UNIT XI

UNIT XII
Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance.

UNIT XIII
Nitrogen metabolism: Inorganic nitrogen species (N2, NO3 and NH3) and their reduction to aminoacids, protein synthesis and nucleic acids.

Unit XIV

UNIT XV

UNIT XVI

Photo morphogenesis: Photo receptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalisation.

**Practical**


Demonstration of photoperiodic response of plants in terms of flowering.

PPH 502  Plant Developmental Biology  Physiological And Molecular Basis  2( 2+0)

Theory

UNIT I

Plant Biodiversity, Concept of evolution in plants.

UNIT II

General Aspects – Novel features of plant growth and development; Concept of plasticity in plant development; Analysing plant growth.

UNIT III

Seed Germination and Seedling Growth – Mobilization of food reserves during seed germination; tropisms; hormonal control of seed germination and seedling growth.

UNIT IV

Shoot, Leaf and Root Development – Organization of shoot apical meristem (SAM); Control of cell division and cell to cell communication; Molecular analysis of SAM; Leaf development and differentiation; Organization of root apical meristem (RAM); Root hair and trichome development; Cell fate and lineages.

UNIT V
Floral Induction and Development – Photoperiodism and its significance; Vernalization and hormonal control; Inflorescence and floral determination; Molecular genetics of floral development and floral organ differentiation; Sex determination.

UNIT VI
Seed Development and Dormancy – Embryo and endosperm development; Cell lineages during late embryo development; Molecular and genetic determinants; Seed maturation and dormancy.

UNIT VII
Senescence and Programmed Cell Death (PCD) – Senescence and its regulation; Hormonal and environmental control of senescence; PCD in the life cycle of plants.

UNIT VIII
Light Control of Plant Development – Discovery of phytochromes and cryptochromes, their structure, biochemical properties and cellular distribution; Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks and their genetic and molecular determinants

UNIT IX
Embryonic Pattern Formation – Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants.

UNIT X
Regeneration and totipotency; Organ differentiation and development; Cell lineages and developmental control genes in maize.

UNIT XI
Special Aspects of Plant Development and Differentiation – Pollen germination and pollen tube guidance; Phloem differentiation; Sex determination in plants;

UNIT XII
Self-incompatibility and its genetic control; Heterosis and apomixis.

PPH 503 Physiological And Molecular Responses of Plants To Abiotic Stresses 3(2+1)

Objective
To apprise the students regarding abiotic stress to plant and its molecular basis.

Theory
UNIT I
Response of plants to abiotic stresses: Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress, Interactions between biotic and abiotic stresses.
UNIT II

UNIT III
Transpiration and its regulation – stomatal functions.

UNIT IV

UNIT V
Molecular responses to water deficit: Stress perception, Expression of regulatory and functional genes and significance of gene products.

UNIT VI
Stress and hormones- ABA as a signaling molecule- Cytokinin as a negative signal. Oxidative stress: Reactive Oxygen Species (ROS). Role of scavenging systems (SOD catalase etc.).

UNIT VII
High temperature stress: Tolerance mechanisms- role of membrane lipids in high temperature tolerance. Functions of HSP’s.

UNIT VIII

UNIT IX
Salinity: Species variation in salt tolerance. Salinity effects at – Cellular and whole plant level, tolerance mechanisms. Salt tolerance in – Glycophytes and halophytes, Breeding for salt resistance.

UNIT X
Heavy metal stress: Aluminium and cadmium toxicity in acid soils. Role of Phytochelatins (heavy metal binding proteins).

Practical
Measurement of water status of plants, determination of osmotic potential by vapour pressure and freezing point depression, Determination of soil water potential and content by psychrometry and other systems. Stress imposition and quantification, Stress –stomatal conductance. Canopy temperature as a reflection of transpiration and root activity, Water use – efficiency, Determination at whole plant and single leaf level, Root- shoot signals-ABA and cytokinin effect on stomatal behavior, Heat tolerance and membrane integrity. Sullivans heat tolerance test, chilling tolerance- Galactolipase and free fatty acid levels as biochemical markers for chilling damage, Cold induced inactivation of O2 evolution of chloroplasts- as a screening technique for chilling tolerance.
PPH 504  Hormonal Regulation of Plant Growth And Development  

Theory

UNIT I

Definition and classification of plant growth regulators- Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones. tricontanol, Phenols –polyamines, jasmonates, Concept of death hormone.

UNIT II

Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberlins, cytokinins, Abscisic acid and Ethylene Brassinosteroids.

UNIT III

Hormone mutants and transgenic plants in understanding role of hormones.

UNIT IV

Signal perception, transduction, and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-S stomatal closure and indution of drought resistance, Ethylene- fruit ripening.

UNIT V


UNIT VI

Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Practical

Quantification of Hormones- Principles of bioassays, physico chemical techniques and immunoassay, Extraction of hormones from plant tissue. Auxins- bioassays- auxins effect onrooting of cuttings, abscission, apical dominance, Gibberellins- bioassays-GA effect on germination of dormant seeds, cytokinin- bioassays- estimation using immunoassay technique cytokinin effect on apical dormance and senescence, ABA bioassayestimation using immunoassay technique. ABA effect on somatal movement, Ethylene bioassays, estimation using physico chemical techniques- effect on breaking dormancy in sunflower and groundnut.

PPH 506  Physiology of Growth And Yield And Modeling  

Theory

UNIT I
Crop growth analysis, key growth parameters. Analysis of factors limiting crop growth and productivity - the concept of rate limitation

UNIT II

Phenology - Growth stages, internal and external factors influencing flowering. Photoperiodic and thermo-periodic responses and the concept of Degree days and crop growth duration.

UNIT III

Canopy architecture, light interception, energy use efficiency of different canopies. LAI, LAD. concept of optimum LAI.

UNIT IV

Source-sink relationships. Translocation of photosynthates and factors influencing transport of sucrose. Physiological and molecular control of sink activity – partitioning efficiency and harvest index.

UNIT V

Plant growth analysis techniques, yield structure analysis, theoretical and actual yields.

UNIT VI

Plant ideotypes,

UNIT VII

Simple physiological yield models - Duncan’s. Monteith’s, and Passioura’s

UNIT VIII

Crop growth models-empirical models testing and yield prediction.

Practical

Plant sampling for leaf area and biomass estimation; analysis of growth and yield parameters – LAD, NAR. CGR, LAI, LAR, SLA portioning efficiency HI, Measurement of light interception, light extinction coefficient, energy utilization efficiency based energy intercepted, and realized, Computer applications in plant physiology, crop productivity and modeling.

**PPH 507 Genome Organization In Higher Plants**

**Theory**

UNIT I

Introduction: Basic discoveries in molecular genetics; basic concepts on genome organization and its replication in prokaryotic systems including cyanobacteria; genome organization in diploids, tetraploids, autotetraploids and polyploids.

UNIT II
Gene & gene expression: Diversity in DNA polymerases; control of plasmid copy number; Regulation of transcription in prokaryotes; Promoters and terminators; Positive and negative control of transcription; Repression and activation-operon concept.

UNIT III
Mitochondrial and chloroplastic genome organization and regulation of gene expression.

UNIT IV
Eukaryotic genome structure: Organization and replication; control of gene expression-transcription and post-transcriptional; promoter analysis; concept of cis elements; transcription factors, function and role of RNA polymerases.

UNIT V
Genetic code and translation-deciphering the genetic code; Codon bias; tRNAs, ribosomes; Initiation and termination of translation; Translational and post-translational controls; Attenuation; Suppressor tRNAs.

UNIT IV
Mobile genetic elements; Structure and function of transposable elements; Mechanism of transposition; Special features of retrotransposans; Repair and recombination.

Practical
Culturing and transformation of bacteria; genomic DNA and plasmid DNA isolation from bacteria, restriction enzyme digestion and analysis by agarose gel electrophoresis, isolation of genomic DNA and RNA from plants and quantification; Culture of bacteriophage; studies on lytic and lysogenic phages.

PPH 508  Morphogenesis, Tissue Culture And Transformation  3(2+1)

Theory
UNIT I
Morphogenesis: The cellular basis of growth and morphogenesis cytodifferentiation.

UNIT II
The cell cycle-cell division and cell organization, cell structure, tissue and organ differentiation. Control of cell division and differentiation in selected cell types, Introductory history, morphogenesis and cellular totipotency.

UNIT III
Introduction to in vitro methods: Terms and definitions, Use of growth regulators, Beginning of in vitro cultures in our country (ovary and ovule culture, in vitro pollination and fertilization), Embryo culture, embryo rescue after wide hybridization and its application, Endosperm culture and production of triploids.

UNIT IV

UNIT V


UNIT VI

Use of plant cells, protoplast and tissue culture for genetic manipulation of plant: Introduction to A. tumefaciens. Tumour formation on plants using A. tumefaciens (Monocots vs Dicots), Root – formation using A. rhizogenes

Practical

*In vitro* culture of different explants such as leaf, stem, shoot apex, cotyledonary nodes; Effect of explant age on propagation potential, Effect of growth regulators auxin, cytokinins and ethylene on callus induction, organogenesis; Somatic embryogenesis, Effect of growth conditions such as temperature and photoperiod on organogenesis, Single – cell suspension cultures.

**PPH 509 Physiology of Crop Plants – Specific Case Studies** 2(2+0)

**Theory**

UNIT I

Crop physiological aspects of rice, wheat, maize, sorghum, millets, sugarcane, pulses, oil seeds, cotton and potato Crops. Six to Eight Species could be chosen based on local importance.

UNIT II

Crop specific topics.

UNIT III

Seed dormancy, photoperiodic and thermoperiodic responses.

UNIT IV

Source-sink relationship, Yield structure and factors influencing yield, Nutrients and other resource requirements and crop specific features.

**PP 510 Physiological And Molecular Aspects Of Photosynthesis-Carbon And Nitrogen Assimilation** 3(2+1)

**Theory**

UNIT I

Photosynthesis- its significance in plant growth, development and bio productivity. Gaseous fluxes in atmosphere.
UNIT II
Physiological and biochemical aspects: chloroplast structure development and replication, ultra structure of thylakoids, photo systems, mechanism of light absorption, chloroplast electron transport chain, Coupling factors and mechanisms of ATP synthesis, and concept of quantum yield.

UNIT III
Photosynthetic carbon reduction cycle and its regulation. CO2 Concentration Mechanism (CCM) as a complementary strategy for carbon fixation. CCM in photosynthetic bacteria, micro algae, Submerged Aquatic macrophages (SAM), C4, CAM and single celled C4 organisms, C3-C4 intermediates. Ecological significance of CCM.

UNIT IV
Rubisco structure, assembly and kinetics, photorespiration and its significance.

UNIT V
Carbon fluxes between chloroplast and cytoplasm and Carbon fixation as a diffusive process, the concept of ra, rs and rm. Pi recycling, starch and sucrose synthesis and export. Concept of canopy photosynthesis, influence of environmental factors such as water stress, high light stress VPD etc.

UNIT VI
Molecular aspects: chloroplast genome organization, expression and regulation of plastid genes Genes regulating potential traits of photosynthesis, biotechnological approaches for improving photosynthetic rate and productivity – transgenics. Conceptual approaches of expressing C4 photosynthesis genes in C3 species.

UNIT VII

UNIT VIII
Prospects of improving photo synthetic rate and productivity – potential traits of photosynthesis- biotechnological approaches.

UNIT IX
Nitrogen assimilation in photosynthesizing cells – NO3-, NO2- reduction, GS-GOGAT pathway. Photorespiration loss of Ammonia and its reassimilation and NUE.

Practical
Extraction and separation of plant pigments, Isolation of chloroplasts ETC reactions- O2 evolution, Determination of rubisco content (western and ELISA), activity and activation state, Enzymatic determination of starch and sucrose, Determination of photosynthetic rates –gas exchange. A, gs, Ci, A/gs, C/gs- intrinsic WUE by gas exchange rates. Light, CO2, VPD

PPH 511 Mineral Nutrition 3(2+1)

Theory

UNIT I
Overview of essential mineral elements, kinetics of nutrient uptake by plants. Biological actions influencing nutrient availability near the root system.

UNIT II
Nutrient uptake by root cells, long distance transport in plants and movement into developing grains. Nutrient transport from vegetative to reproductive organs during reproductive stage of growth and maturity.

UNIT III
Molecular mechanism of ion uptake, ion transporters, specific examples of transporters for Nitrate, Phosphate, Potassium and other nutrients. Multiple transporters for a single ion and their functional regulation.

UNIT IV
Molecular physiology of micronutrient acquisition. Examples of genes encoding mineral ion transporters. Strategies plants adopt to acquire and transport minerals under deficient levels.

UNIT V
Physiological and molecular mechanisms underlying differential nutrient efficiency in crop genotypes, Examples of Phosphorous, Iron and Zinc efficient crop varieties.

UNIT VI
Breeding crop varieties for improved nutrient efficiency. Plant responses to mineral toxicity.

Practical
Physiological and biochemical changes in plants under nutrient sufficiency and deficiency levels. Quantification of pigment levels, enzyme activities.
Ph.D. Courses

PPH 601  Functional Genomics And Genes Associated With A Few Physiological Processes  2(2+0)

Theory

UNIT I

UNIT II
Genetic tools for plant development- Understanding the importance of mutants in unraveling the physiological processes – T-DNA insertion mutants, Gain in function, Transposon mutagens, Transposition, Physical and Chemical mutagenesis, Gene and Enhancer Traps for Gene Discovery, High-Throughput TAIL-PCR as a Tool to identify DNA Flanking insertions, High-Throughput TILLING for functional Genomics.

UNIT III
Gene knock out approaches: Antisense technology, Virus induced gene silencing (VIGS), Custom Knock-outs with Haripin RNA-mediated Gene Silencing and other silencing tools, Complementation studies, DNA micro arrays.

UNIT IV
Gene Over expression approaches: Vector Construction for Gene Overexpression as a Tool to Elucidate Gene Function; Transient expression, Transgenics.

UNIT VI
Proteomics: Networking of Biotechnology for interpreting gene functions. Yeast two hybrid systems to study protein – protein interaction to study gene functions, Proteomics as a Functional Genomics Tool, Crystallographic and NMR approaches to determine protein structures.

UNIT VII
Functional characterization of genes associated with important cellular processes influencing crop growth and development.

UNIT VIII
Case studies of genes controlling photosynthesis, respiration, photorespiration, fatty acid biosynthesis, nutrient uptake, flowering, seed protein quality and quantity.

PPH 602  Signal Perceptions And Transduction And Regulation of Physiological Processes  2(2+0)

Theory

UNIT I
General aspects: Introduction to signaling-Long range (Diffusible) signaling and short range (contact) signaling. Components of signaling- Upstream components: receptor and ligands concept-types of ligands and its relevance-receptor

UNIT II
Hormone signaling: Hormone binding receptors-Transduction process. Effector molecules and gene expression.

UNIT III
Specific signaling pathways of Auxins, Cytokinins, Gibberellins, Ethylene, ABA, Brassinosteroids which leads to formative effects. The cross talk in the signaling of different hormones-significance of studies with hormone action mutants.

UNIT IV

UNIT V

UNIT VI
Cross talk between signaling pathways.

UNIT VII
Signal perception and transduction in plant defense responses: Role of salicylic acid and active oxygen species.

UNIT VIII
Signaling cascade during leaf senescence, abscission, flowering and tuberisation

UNIT IX
Carbon and Nitrogen as signaling agents in Plant Metabolism.

PPH 603  Molecular Approaches For Improving Physiological Traits 3(2+1)

Theory

UNIT I
Importance of Molecular Breeding for complex multi-gene controlled physiological traits and its relevance in augmenting trait based breeding. Physiological traits with relevance to growth, development, abiotic stress tolerance, nutrient acquisition, Approaches for accurate phenotyping of large germplasm accessions and/or mapping populations.
UNIT II
The advantages of “Trait based” breeding approaches. Concept of segregation, independent assortment and linkage. The concept of molecular markers, various types of Dominant and Co-dominant marker systems.

UNIT III
Relevance and development of mapping populations and genetic analysis using marker systems. Advantages of association mapping and the concept of linkage, LD decay and population structure.

UNIT IV
Statistical analysis to assess the variance in phenotypic traits and molecular data. Assessment of genetic parameters such as heritability, genetic advance etc.

UNIT V
Strategies for QTL introgression and Marker Assisted Selection (MAS). Map based cloning of novel genes and alleles. Allele mining

UNIT VI
Transgenic approach in improving physiological processes- Introduction to GMOs and application in crop improvement; gene mining, sequence structure & function analysis using bioinformatics tools, identification of candidate genes for various physiological process associated with specific traits (such as stress tolerance) and their potential benefits in transgenic crops.

UNIT VII
Cloning full-length candidate genes, stress inducible promoters, strategies to clone and characterize and make constructs for specific crops, gene stacking strategies, tissue specific expression and functional validation of genes.

UNIT VIII
Transformation of crop plants-Agrobacterium and use of other organisms for transformation-particle gun transformation and other methods.

UNIT IX
Selection of transformants- molecular analysis on the basis of qRT-PCR, Southern, Northern analysis and immunoassays; estimation of copy number. Concept of desirable number of independent events.

UNIT X
Evaluation of transgenics on basis of empirical/physiological/biochemical process under specific conditions on the basis of gene function. Generation of T1 populations, event characterization and generation of molecular data as per the regulatory requirements.

UNIT XI
Issues related to Biosafety and Registration of Transgenic Agricultural Organisms, methods to detect GMOs from agricultural products.
Practical


PPH 604 Techniques In Plant Physiology 3(1+2)

Theory

UNIT I

Recent experimental techniques to study various physiological processes, Photosynthetic gas exchange measurements, light and CO2 response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements.

UNIT II

Estimation of water use efficiency at whole plant and single leaf level. Use of stable isotopes to understand physiological processes.

UNIT III

Radio isotopes in plant biology.

UNIT IV

Tools and techniques (molecular and biochemical) to study physiological processes and to screen & assess stress responses in plants, such as (a) DNA & RNA isolation, cDNA synthesis & library construction, semiquantitative & quantitative RT-PCR, northern blot, immunoassays; (b) techniques for defined physiological processes.

UNIT V

Methods to phenotype germplasm for specific physiological traits.

UNIT VI

Quantification of mineral nutrients using advanced instruments like AAS, & ICP.

UNIT VII

Techniques in plant transformation & analysis of transgenic plants

UNIT VIII
Molecular markers- genetic distance and mapping population concept of linkage maps and identification of QTLS.

UNIT IX

Instrumentation: Acquaintance of the operation of specific instruments important in physiological research like Mass spec., phosphor-imager, DNA sequencer, spectro-fluorometer, oxygen electrode, etc.

Practical

Photosynthetic gas exchange measurements, light and CO2 response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements. Estimation of water use efficiency at whole plant and single leaf level. Use of stable and radioactive isotopes to understand physiological processes. DNA & RNA isolation, cDNA synthesis & library construction, semiquantitative & quantitative RT-PCR, northern blot, immunoassays; techniques for defined physiological processes, Quantification of mineral nutrients using advanced instruments like AAS.

PPH 605 Climate Change And Crop Growth 2(2+0)

Theory

UNIT I

History and evidences of climate change and its implications. Effect of climate change on monsoons, hydrological cycle and water availability.

UNIT II

Natural and anthropogenic activities and agricultural practices on GHG production, Monitoring of greenhouse gases and their influence on global warming and climate change, Ozone depletion leading to increased ionizing radiations and its implications on crop growth.

UNIT III

Long-term and short-term projections of climate change effects on natural vegetations and ecosystems, crop-pest interaction, area shift, food production and supply.

UNIT IV

Approaches to mitigate climate change through studies on plant responses.

UNIT V

Direct and indirect effects of climate change on plant processes – phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield.

UNIT VI

Conventional and biotechnological approaches to improve the crop adaptation to climate change. Relevance of “Genome wide mutants” to identify genes/processes for improved adaptation to changing environments
International conventions and global initiatives on Carbon sequestration, carbon trading.

PPH 606 Post Harvest Physiology 3(2+1)

Theory

UNIT I
Environmental factors influencing senescence, ripening and post harvest life of flowers, vegetables and seeds.

UNIT II
Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening.

UNIT III
Senescence associated genes and gene products.

UNIT IV
Functional and ultrastructural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening.

UNIT V
Regulatory role of ethylene in senescence and ripening, ethylene biosynthesis, perception and molecular mechanism of action.

UNIT VI
Post harvest changes in seed and tubers biochemical constituent’s quality parameters. Effect of environmental factors on post harvest changes in seed and tubers.

UNIT VII
Biotechnological approaches to manipulate ethylene biosynthesis and action.

UNIT VIII
Alternate post harvest methodology and quality attributes. Scope for genetic modification of post harvest life of flowers and fruits.

UNIT IX
Uses of GM crops and ecological risk assessment.
Practical

Physiological and biochemical changes during senescence and ripening, Estimation of ethylene during senescence and ripening, determination of Reactive Oxygen Species and scavenging enzymes, Measurement of dark and alternate respiration rates during senescence and ripening. Estimation of ripening related enzyme activity, Cellulases pectin methyl esterases, polygalacturonase etc.

PPH 607 Weed Physiology And Herbicide Action 2(1+1)

Theory

UNIT I

Weed biology, ecology and physiology. Weed and crop competition, allelochemicals, their nature and impact. Weed-seed physiology.

UNIT II

Classification of herbicides and selectivity. Recent concepts on entry, uptake, translocation and metabolism of soil and foliar applied herbicides. Environmental and plant factors influencing entry, uptake and translocation of herbicides.

UNIT III

Classification and chemistry of common herbicides. Physiological, biochemical and molecular mechanism of action of different groups of herbicides; ACC synthase inhibitors, ALS inhibitors, Mitotic inhibitors, Cellulose biosynthesis inhibitors, Inhibitors of fatty acid biosynthesis, inhibitors of Photosynthesis, Auxinic Herbicides, New herbicides,

UNIT IV

Metabolic pathway of herbicide degradation in plants and soil. Herbicide adjuvants and their classification.

UNIT V

Molecular mechanism of action of herbicide synergists and antagonists.

UNIT VI

Physiological and molecular mechanism of herbicide selectivity.

UNIT VII

Herbicide resistant crops; transgenic & tissue culture approaches to develop herbicide tolerant varieties

Practical

Adjuvants and their effect on spray droplets, chemical entry and transport. Determination of physiological and biochemical processes like photosynthesis, respiration, cell division, Protein & fatty acid synthesis, membrane permeability as affected by herbicides. Quantification of pigment levels in leaves, specific enzyme activities affected by herbicides. Demonstration of translocating type of herbicides by radio labeling studies.
Theory

UNIT I
Seed and fruit development, seed and fruit abortion, proximate mechanism of seed and fruit abortion. Hereditary and environmental effect on seed development. Gene imprints and seed development.

UNIT II
Importance of seeds, seed structure and function, physiological and biochemical changes, environmental influences, physiology of seed and fruit development; seed and fruit abortion and means to overcome it; proximate mechanisms of seed and fruit abortion.

UNIT III
Structure of seeds and their storage resources, seed developmental patterns and source of assimilates for seed development.

UNIT IV
Pathway of movement of assimilates in developing grains of monocots and dicots, Chemical composition of seeds, Storage of carbohydrates, proteins and fats in seeds and their biosynthesis.

UNIT V
Seed respiration, mitochondrial activity, Seed ageing. Mobilization of stored resource in seeds, Chemistry of oxidation of starch, proteins and fats, Utilization of breakdown products by embryonic axis.

UNIT VI
Control processes in mobilization of stored resources, Role of embryonic axes, Gibberellin and a-amylase and other hydrolytic activity. Seed maturation phase and desiccation damage, Role of LEA proteins.

UNIT VII
Seed viability, Physiology of and means to prolong seed viability, Seed vigour: concept, importance, measurement; invigoration: methods and physiological basis of it, Seed dormancy, types and regulation, Means to overcome seed dormancy.

Practical
Determination of seed storage proteins, Sink drawing ability of ovules, empty ovule technique, Alpha-amylase activity in germinating seeds, Role of GA in inducing amylase activity, Role of embryo in GA induced amylase activity, Protease and lipase activity in germinating seeds, Seed viability test and accelerated ageing test. Seed hardening/osmotic priming of seeds, Seed respiration rates, Seed viability losses through membrane leakage studies.
## List of Courses

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<td>SSC-211</td>
<td>Biochemistry</td>
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<td>SSC 509</td>
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<td>SSC 510</td>
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<tr>
<td>SSC 511</td>
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SSC 514  FERTILIZER TECHNOLOGY  1(1+0)
SSC 515  LAND DEGRADATION AND RESTORATION  1(1+0)
SSC 591  MASTER’S SEMINAR  1(1+0)
SSC 599  MASTER’S RESEARCH  20

**Ph.D. Courses**

SSC 601  ADVANCES IN SOIL PHYSICS  3(2+1)
SSC 602  ADVANCES IN SOIL FERTILITY  3(2+1)
SSC 603  PHYSICAL CHEMISTRY OF SOILS  2(2+0)
SSC 604  SOIL GENESIS AND MICROPEDOLOGY  2(2+0)
SSC 605  BIOCHEMISTRY OF SOIL ORGANIC MATTER  3(2+1)
SSC 606  LAND USE PLANNING AND WATERSHED MANAGEMENT  2(2+0)
SSC 607  ADVANCES IN SOIL MICROBIOLOGY  3(2+1)
SSC 608  ADVANCED INSTRUMENTAL TECHNIQUES  3(2+1)
SSC 691  DOCTORAL SEMINAR I  1(1+0)
SSC 692  DOCTORAL SEMINAR II  1(1+0)
SSC  SYNOPSIS SEMINAR
SSC  PRE-SUBMISSION SEMINAR
SSC 699  DOCTORAL RESEARCH  45
B.Sc. (Ag.) Courses

SSC-121 Introduction to Soil Science 3 (2+1)

Soil: Pedological and edaphological concepts, Origin of the earth, Earth’s crust; Composition: Rocks and minerals Weathering, Soil formation factors and processes, Components of soils; Soil profile, Soil physical properties, Soil texture, Textural classes, Particle size analysis, Soil structure Classification, Soil aggregates, significance, Soil consistency, Soil crusting, Bulk density and particle density of soils & porosity, their significance and manipulation, Soil compaction, Soil Colour, Elementary knowledge of soil classification and soils of India; Soil water. Retention and potentials, Soil moisture constants, Movement of soil water, Infiltration, percolation, permeability, Drainage, Methods of determination of soil moisture Thermal properties of soils, Soil temperature, Soil air, Gaseous exchange, Influence of soil temperature and air of plant growth; Soil colloids, Properties, nature, types and significance; Layer silicate clays, their genesis and sources of charges, Adsorption of ions, Ion exchange, CEC & AEC Factors influencing ion exchange and its Significance. Soil organic matter, composition, Decomposability, Humus, Fractionation of organic matter, Carbon cycle, C:N ratio. Soil biology, Biomass, Soil organisms and their beneficial and harmful roles.


SSC-211 Biochemistry 3(2+1)

Practical: Amino acid models (atomic); Paper electrophoresis for the separation of plant pigments; Protein denaturation – heat, pH, precipitation of proteins with heavy metals, Protein estimation by Lowry method; Enzyme kinetics, competitive inhibition, enzyme immobilization; Extraction of nucleic acids, column chromatography of RNA hydrolysate; Characterization of lipids by T.L.C.; Extraction of oil from oil seeds; Estimation of fatty acids by G.L.C.; Models of sugars, sucrose & starch; Quantitative determination of sugars; Paper chromatography for the separation of sugars; Determination of phenols.

SSC-221 Fertilizes and Agro-Chemicals 3(2+1)

Introduction – Raw materials – Manures – Bulky and concentrated- FYM, composts – Different methods, Mechanical compost plants, Vermicomposting, Green manures, Oil cakes, Sewage and sludge – Biogas plant slurry, Plant and animal refuges. Fertilizers – classifications, Manufacturing processes and properties of major nitrogenous (ammonium sulphate, urea, calcium ammonium nitrate, ammonium sulphate nitrate) phosphatic (single super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate), potassic and complex fertilizers their fate and reactions in the soil, Secondary and micro nutrients fertilizers, Amendments. Fertilizer Control Order, Fertilizer storage; Biofertilizers and their advantage, Organic chemistry as prelude to agro chemicals, Diverse types of agrochemicals, Botanical insecticides (Neem), Pyrethrum, Synthetic pyrethroids. Synthetic organic insecticides, Major classes, Properties and uses of some important insecticides under each class. Herbicides – Major classes – Properties and uses of 2, 4-D, atrazine, glyphosate, butachlor bentiocarb; Fungicides – Major classes – Properties and uses of carbendazim, carboxin, captain, tridemorph and copper oxychloride – Insecticides Act, Plant growth regulators.


SSC-321 Soil Chemistry, Soil Fertility and Nutrient Management 3(2+1)


**M.Sc. (Ag.) Courses**

**SSC 501 Soil Physics**

**Theory**

UNIT I
Scope of soil physics and its relation with other branches of soil science; soil as a three phase system. **UNIT II**
Soil texture, textural classes, mechanical analysis, specific surface. **UNIT III**
Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.

**UNIT IV**
Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

**UNIT V**
Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

**UNIT VI**
Water flow in saturated and unsaturated soils, Poiseuille’s law, Darcy’s law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils. **UNIT VII**
Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

**UNIT IX**
Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

**UNIT X**
Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil
temperature; soil temperature in relation to plant growth; soil temperature management.

Practical
- Mechanical analysis by pipette and international methods
- Measurement of Atterberg limits
- Aggregate analysis - dry and wet
- Measurement of soil-water content by different methods

Measurement of soil-water potential by using tensiometer and gypsum blocks
Determination of soil-moisture characteristics curve and computation of pore-size distribution
Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of aeration porosity and oxygen diffusion rate
- Soil temperature measurements by different methods
- Estimation of water balance components in bare and cropped fields

SSC 502 Soil Fertility And Fertilizer Use 4 Crs. (3+1)

Objective
To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory
UNIT I
Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. UNIT II
Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation - types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.
UNIT III
Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.
UNIT IV
Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT V
Sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium – factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

UNIT VI
Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

UNIT VII
Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions.

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

UNIT IX
Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical
- Principles of colorimetry
- Flame-photometry and atomic absorption spectroscopy
- Chemical analysis of soil for total and available nutrients
- Analysis of plants for essential elements

SSC 503 Soil Chemistry 3Crs. (2+1)

Objective
To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

UNIT I
Chemical (elemental) composition of the earth’s crust and soils. UNIT II
Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT III
Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; clay-organic interactions.

UNIT IV
Ion exchange processes in soil; cation exchange-theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny’s concept), adsorption isotherms, donnan-membrane equilibrium concept, ionic activity measurement, thermodynamics, anion and ligand exchange - inner- sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.
UNIT V
Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT VI
Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.

UNIT VII
Chemistry of salt-affected soils and amendments; soil pH, EC, ESP, SAR and important relations; soil management and amendments.

UNIT VIII
Chemistry and electrochemistry of submerged soils.

Practical
- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, E_h by the use of E_h-pH meter and conductivity meter
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method
- Potentiometric and conductometric titration of soil humic and fulvic acids
- (E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ (E_4/E_6) values at two pH values
- Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
- Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved
- Determination of titratable acidity of an acid soil by BaCl_2-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

SSC 504 Soil Mineralogy, Genesis, Classification And Survey 3 Crs. (2+1)

Objective
To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory
UNIT I
Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

UNIT II
Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils.

UNIT III
Concepts and definitions of soil, soil profile; Formation and weathering of rocks and mineral, weathering sequences of minerals. Factors of soil formation, soil forming processes.

UNIT IV
Concept of soil individual; soil classification systems - historical developments and modern systems of soil classification with special emphasis on soil taxonomy; application of soil taxonomy.
UNIT V
Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping.

UNIT VI
Landform – soil relationship; major soil groups of India and UP.; land capability and irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical
- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use
- Cartographic techniques
- Land use planning exercises using conventional and RS tools

SSC 505  Soil Erosion And Conservation  3(2+1)

Theory
UNIT I
History, distribution, identification and description of soil erosion problems in India.

UNIT II
Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI₃₀ index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT III
Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT IV
Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

UNIT V
Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT VI
Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio-economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical
- Determination of different soil erodibility indices, percolation ratio, raindrop erodibility index
- Computation of kinetic energy of falling rain drops
- Computation of rainfall erosivity index (EI₃₀) using rain gauge data
- Visits to a watersheds
Theory
UNIT I
Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II
Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora.

UNIT III
Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, basic principles of humus formation.

UNIT IV
Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V
Preparation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI
Biofertilizers – Definition, classification, specifications, method of production and role in crop production.

Practical
• Determination of soil microbial population
• Soil microbial biomass
• Elemental composition, fractionation of organic matter and functional groups
• Decomposition of organic matter in soil
• Soil enzymes
• Measurement of important soil microbial processes such as ammonification, nitrification, N₂ fixation, S oxidation, P solubilization and mineralization of other micro nutrients
• Study of rhizosphere effect

Theory
UNIT I
General introduction to geology and geochemistry, major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India.

UNIT II
Methodology of geomorphology, its agencies, erosion and weathering; soil and physiography relationships; erosion surface of soil landscape.

UNIT III
Geochemical classification of elements; geo-chemical aspects of weathering and migration of elements; geochemistry of major and micronutrients, trace and other human essential elements.
Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter

UNIT II
Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography

UNIT III
Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in soil & plant studies

UNIT IV
Doses of radiation exposure, radiation safety aspects regulatory aspects, collection, storage and disposal of radioactive wastes

Practical
- Storage and handling of radioactive materials
- Determination of half life and decay constant
- Preparation of soil and plant samples for radioactive measurements
- Setting up of experiment on fertilizer use efficiency and cation exchange equilibria using radioisotopes
- Determination of A, E and L values of soil using $^{32}\text{P}/^{65}\text{Zn}$
- Use of neutron probe for moisture determination
- Sample preparation and measurement of $^{15}\text{N}$ enrichment by mass spectrophotometry/emission spectrometry

SSC 509 Soil, Water And Air Pollution 3(2+1)

Theory
UNIT I
Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II
Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT III
Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV
Pesticides – their classification, behavior in soil and effect on soil micro-organisms.

UNIT V
Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI
Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide.

UNIT VIII
Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practical
- Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in
effluents
- Heavy metals and pesticides in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety
- Air sampling and determination of particulate matter and oxides of sulphur
- Visit to various industrial sites to study the impact of pollutants on soil and plants

**SSC 510 Remote Sensing And GIS Techniques For Soil, Water And Crop Studies** 3(2+1)

**Theory**

UNIT I
Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II
Sensor systems - camera, microwave radiometers 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

**SSC 511 Analytical Techniques And Instrumental Methods In Soil And Plant Analysis** 2 (0+2)

**Practical**

UNIT I
Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation-reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT II
Principles of visible, ultraviolet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractrometry; identification of minerals by X-ray by different methods.

UNIT III
Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.
SSC 512  System Approaches In Soil And Crop Studies  3(2+1)
Theory
UNIT I
Systems concepts - definitions, general characteristics; general systems theory; systems thinking, systems dynamics, systems behavior and systems study.
UNIT II
Model: definition and types; mathematical models and their types; modeling: concepts, objectives, processes, abstraction techniques; simulation models, their verification and validation, calibration; representation of continuous systems simulation models - procedural and declarative.
UNIT III
Simulation - meaning and threats; simulation experiment, its design and analysis.
UNIT IV
Application of simulation models in understanding system behavior, optimizing system performance, evaluation of policy options under different soil, water, nutrient, climatic and cultural conditions; decision support system, use of simulation models in decision support system.
Practical
• Use of flow chart or pseudo-code in the program writing
• Writing a small example simulation model program - declarative (in Vensim PLE, Stella or Simile) and procedural (in Java, Fortran, QBASIC or V Basic)
• Conducting simulation experiments in DSSAT, WOFOST or EPIC with requirement of report and conclusion

SSC 513  MANAGEMENT OF PROBLEM SOILS AND WATERS  3(2+1)
Theory
UNIT I
Area and distribution of problem soils – acidic, saline and sodic soils; origin of problematic soils, and factors responsible.
UNIT II
Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.
UNIT III
Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.
UNIT IV
Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.
UNIT V
Quality of irrigation water; management of brackish water for irrigation; characterization of brackish waters; relationship in water use and quality.
UNIT VI
Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.
Practical
• Characterization of acid, acid sulfate, salt-affected and calcareous soils
• Determination of cations (Na⁺, K⁺, Ca²⁺ and Mg²⁺) in ground water and soil samples
• Determination of anions (Cl⁻, SO₄²⁻, CO₃⁻ and HCO₃⁻) in ground waters and soil samples
**SSC 514  Fertilizer Technology**  1(1+0)

**Theory**

**UNIT I**
Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states; fertilizer control order. **UNIT II**
Manufacturing processes for different fertilizers using various raw materials, characteristics and nutrient contents.

**UNIT III**
Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order.

**UNIT IV**
New and emerging issues in fertilizer technology – production and use of slow and controlled release fertilizers, supergranules fertilizers and fertilizers for specific crops/situations.

**SSC 515  Land Degradation And Restoration**  1(1+0)

**Theory**

**UNIT I**
Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna, biodegradation and environment.

**UNIT II**
Land restoration and conservation techniques - erosion control, reclamation of salt-affected soils; mine land reclamation, afforestation, organic products.

**UNIT III**
Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

**Ph.D. Courses**

**SSC 601  Advances In Soil Physics**  3(2+1)

**Theory**

**UNIT I**
Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system.

**UNIT II**
Fundamentals of fluid flow, Poiseuilles law, Laplace’s equation, Darcy’s law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcy’s law; numerical solution for one dimensional water flow.

**UNIT III**
Theories of horizontal and vertical infiltration under different boundary conditions. Theories of nutrient dynamics in soil.

**UNIT IV**
Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.
UNIT V
Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.

UNIT VI
Soil crust and clod formation; structural management of puddled rice soils; soil conditioning - concept, soils conditioners - types, characteristics, working principles, significance in agriculture.

UNIT VII
Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

SSC 602 Advances In Soil Fertility 3(2+1)
Theory
UNIT I
Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices. UNIT II
Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.
UNIT III
Chemical equilibria (including solid-solution equilibria) involving nutrient ions in soils, particularly in submerged soils.
UNIT IV
Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.
UNIT V
Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.
UNIT VI
Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.
UNIT VII
Organic residues as plant nutrient sources; crop residues, GM, green leaf manuring, compost, FYM and other concentrated organic manures

SSC 603 Physical Chemistry of Soils 2(2+0)
Theory
UNIT I
Colloidal chemistry of inorganic and organic components of soils - their formation, clay organic interaction. UNIT II
Predictive approaches for cation exchange equilibria - thermodynamics, empirical and diffuse double layer theory (DDL) - relationships among different selectivity coefficients; structure and properties of diffuse double layer. UNIT III
Nutrient transformations in soils; cationic and anionic exchange and interaction in soil.
UNIT IV
Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

UNIT V
Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

 SSC 604 Soil Genesis And Micropedology 2(2+0)
Theory
UNIT I
Evolution and composition of Earth: Division of Earth sphere, composition of earth crust, relative abundance of rocks in the earth crust
UNIT II
Weathering and soil formation – factors and pedogenic processes; Pedogenesis and taxonomy of Indian soils.
UNIT III
Assessment of soil profile development by morphological, mineralogical and chemical analysis.
UNIT IV
Micro-pedological features of soils – their structure, fabric analysis, role in genesis and classification.

 SSC 605 Biochemistry of Soil Organic Matter 3(2+1)
Theory
UNIT I
UNIT II
Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.
UNIT III
Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.
UNIT IV
Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes.
UNIT V
Humus - pesticide interactions in soil, mechanisms.

 SSC 606 Land Use Planning And Watershed Management 2(2+0)
Theory
UNIT I
Concept and techniques of land use planning; factors governing present land use.
UNIT II
Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.
UNIT III
Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production. Status of
LUP in India
UNIT IV
Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.
UNIT V
Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

SSC 607 Advances In Soil Microbiology 3(2+1)

Theory
UNIT I
Microbial and biochemical indicators of soil health – microbial population, MB-C, MB-N, MB-P, soil respiration and soil enzymes
UNIT II
PGPR-mechanism, concern microbes, quality parameters, interaction among them and with plant pathogens, bioformulations of biofertilizers
UNIT III
Molecular study of Rhizobium – legume symbiosis
UNIT IV
Microbial biodiversity of soil, soil DNA and metagenomic
UNIT V
Important microbial process in soil, microbial interaction in soil, nitrification inhibitors

SSC 608 Advanced Instrumental Techniques 3(2+1)

Theory
UNIT I
Electrochemical techniques: Conductimeter, Karl Fisher auto titrator, Ion meter
UNIT II
Spectrometric techniques: UV-VIS spectrophotometer, Flame Photometer, Atomic absorption spectrophotometer, ICP-AES and ICP-MS, IR-spectrophotometer and NMR
UNIT III
Chromatographic techniques: HP-TLC, GLC, HPLC, ion-chromatography and electrophoresis techniques
UNIT IV
Thermal techniques: Thermogravimetry (TG), Differential thermal analysis (DTA) and pyrolysis
## Module I - Crop Production

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<tr>
<th>Course code</th>
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<tr>
<td>AGR (E) 421</td>
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<tr>
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<td>Water Management (Watershed, Micro-irrigation, Utilization of problematic water)</td>
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<td>*GPB (E) 421</td>
<td>Seed Production Technology</td>
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<td>SSC (E) 421</td>
<td>Biofertilizer</td>
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## Module II - Crop Protection, Apiculture & Mushroom Culture

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<td>MPP (E)-421</td>
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** MPP, EAZ, & PPH
### Module –III: HORTICULTURE

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<td>Commercial Floriculture</td>
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<tr>
<td>HOR (E)-423</td>
<td>Nursery Management of Horticultural Crops</td>
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<tr>
<td>HOR(E)-424</td>
<td>Commercial Vegetable Production</td>
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### Module –IV: Basic Science

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<td>Microbial Technology</td>
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<td>GPB (E)-424</td>
<td>Recombinant DNA Technology</td>
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<td>Plant Tissue Culture</td>
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<td>Financial Management of Agri-business</td>
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<tr>
<td>EXT(E)-421 5(0+5)</td>
<td>Project Formulation, Evaluation and Monitoring</td>
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<td>EXT(E)-422 5(0+5)</td>
<td>Information and Communication Management</td>
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## Module VI: Processing and Value Addition

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<td>ENG(E)-421 5(0+5)</td>
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<tr>
<td>ENG(E)-422 5(0+5)</td>
<td>Processing and Value Addition of Pulses and Oilseeds</td>
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<tr>
<td>*ENG(E)-423 5(0+5)</td>
<td>Processing and Value Addition of Fruits, Vegetables and Dairy products</td>
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<tr>
<td>**ENG(E)-424 5(0+5)</td>
<td>Processing and Value Addition of Aromatic Plants and Spices</td>
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**Cross listed with SSC.
DETAILS OF EXPERIENTIAL LEARNING COURSES

MODULE – I (CROP PRODUCTION)

AGR(E)-421 - Integrated Farming System 5(0+5)

UNIT-I Terminology used in farming systems: Crop system, cropping system, Cropping pattern, Farming system, Specialized farming system (SFS), integrated Farming System (IFS)

UNIT-II Indices used in cropping systems and their application under field conditions: equivalent yield, system productivity, system profitability, land use efficiency, man days, net return, B: C ratio, land equivalent ratio, relative area time equivalent ratio, crowding co-efficient, competitive ratio, aggressiveness, actual yield loss, monetary advantage.

UNIT-III Farming system research: Concept, principles and objectives; steps involved in FSR.

UNIT-IV Integrated farming system: Goals, advantages and components. Integrated farming systems for different agro-climatic zones.

UNIT-V Development of Integrated farming system modules for small and marginal farmers under rainfed and irrigated eco-system.

Management of different components of IFS under actual field conditions: crop dairy, fishery, poultry backyard poultry, mushroom, orchard, value addition, year round production of green fodder, NADEP and vermicompost.

AGR(E) 422 - Water Management (Watershed, Micro-irrigation, Utilization of problematic water) 5(0+5)

UNIT-I Identification, handling, precaution and use of different instruments used in water management.

UNIT-II Soil moisture measurement: Soil moisture content (field method, gravimetric and volumetric method, neutron scattering method, time-domain reflectometry and capacitance sensor method); Soil moisture constants- field capacity, permanent wilting point and ultimate wilting point in soil (tensiometer, resistance block, pressure plate apparatus, psychrometer)

UNIT-III Rainfall measurement by rain gauge and problems on calculation of effective rainfall. Measurement of ET by lysimeter, field experimental plots, soil moisture depletion studies, open pan evaporimeter, and climatological (Thornwaite Blaney – Criddle, Pennam, Modified...
UNIT-IV Scheduling of Irrigation by different methods viz., IW/CPE ratio, soil-cum sand mini plot technique. Problem on calculation of water use efficiency and water requirement in different crops/cropping system. Irrigation management under scarce water situations.

UNIT-V Measurement of irrigation water by direct (velocity area, flow meter, average cross section, trajectory measurement) and constriction flow (weirs, flumes, orifice) methods. Demonstration of surface, drip, sprinkler irrigation system and water saving technologies.

UNIT-VI Sewage water standards and laboratory determination of water quality (viz electrical conductivity, cations and anions, acidity/basicity, sodium absorption ratio) and their management.

UNIT-VII Drainage: Drainage coefficient, drainage requirement, preparation and maintenance of surface and subsurface drainage system. Hydrological unit of India, process of delineation of water shed and water shed management at micro-level.

3. *GPB (E)-421 Seed Production Technology 5(0+5)

(Cross listed with AGR)

UNIT-I: Test for genuineness of variety/hybrid and parental lines of important crops : Characterization of hybrids, varieties and parental lines through DUS testing & molecular markers, varietal identification through electrophoresis; Grow out test (GOT)
Seed testing : Seed sampling, seed heterogeneity, moisture test, physical purity analysis, determination of other species, genetic purity test, germination test, viability test, seed vigour test, seed health test, coated test, tolerance value, real value of seed, calculation of seed requirements of various crops based on test values.

UNIT-I: Seed production & processing : General principles and methods of seed production, maintenance of nucleus and breeder’s seed, hybrid seed production techniques.
Seed production techniques of major field crops and vegetables. Layout of seed processing plant, seed blending, conditioning, seed drying, seed cleaning, grading.
Seed treatment, bagging and storage : Seed priming, treatment for breaking dormancy, Bacterial culture treatments, chilling treatment for vernilization effect, seed treatment for control of insect pest and disease, method of bagging, method of seed storage.

UNIT-I: Seed certification and legislation : Method of seed certification, field inspection, minimum certification standards, seed law enforcement, the protection of plant varieties and farmer’s right
Visit to Seed Processing Units

**SSC (E)-421  Biofertilizer**  

5(0+5) 

**UNIT I-** Prospects of biofertilizers in India agriculture.

**UNIT II-** Microorganisms used as biofertilizer. Isolation of *Rizobium, Azotobacter, Azospirillum* and phosphate solubilizers in soils.

**UNIT III-** Identification, testing and selection of efficient strains.

**UNIT IV-** Quality of carrier materials. Preparation of carrier and liquid bacterial bio fertilizers formulation.

**UNIT V-** Testing of biofertilizers quality. Inoculation techniques, preparation of BGA and mycorrhizal cultures.
MODULE –II (CROP PROTECTION APICULTURE & MASROOM CULTUR)

EAZ (E) -421-Apiculture 5(0+5)

UNIT I- Apiculture – Scopes and prospects.
UNIT II- Identification, morphology, life history and structural adaptations of bees. Distinguishing bee castes.
UNIT III- Bee keeping appliances.
UNIT V- Identification and management of bee pests and diseases.
UNIT VI- Honey extraction and processing. Other hive products – bees wax, pollen, bee venom, propolis and royal jelly – methods extraction and uses. Role of bees in cross pollination – their exploitation –
UNIT VII- Case studies with selected crops.
UNIT VIII- Production and marketing of quality, honey and value added honey products.
UNIT IX- Effect of agricultural inputs on bee activity – Symptoms of pesticide poisoning Visit to bee nursery and commercial apiaries.

2. *EAZ(E)-422-Bio-control Agents and Bio-pesticides 5(0+5)

Cross listed with MPP

UNIT I- Identification of common natural enemies (parasitoids, predators and pathogens) of crop pests and weeds.
UNIT II- Biology- parasitization/predatory potential of common parasitoids and predators.
UNIT III- Pathogenicity of virus, bacteria and fungi.
UNIT IV- Compatibility of biocontrol with botanicals and chemical pesticides.
UNIT V- Mass production of predators, parasitoids and pathogens. Experiments to show the effect of Semiochemicals in host selection.
MPP (E)-421- Mushroom Culture  

Unit–I Preparation of culture media for mushrooms, preparation of mushroom culture by tissue culture and by spore print techniques, identification of edible and poisonous mushrooms, microbial contamination during spawn making and their solutions.

Unit–II Preventive measures adopted for mushroom spawn laboratory, layout of mushroom farm, mushroom spawn production.

Unit–III Formulation of compost and casing materials, preparation of compost by long and short methods, Compost supplements, cultivation methods of white button mushroom (Agaricus bisporus) and oyster mushroom (Pleurotus spp.)

Unit–IV Cultivation method of milky (Calocybe indica), paddy straw (Volvariella spp.) and medicinal mushroom (Ganoderma lucidum), Preservation and processing of mushrooms.

Unit–V Identification and management of diseases of white button and oyster mushroom, insect pests, mites and nematodes of mushrooms, biotic abnormalities of mushrooms and their management. Observation and measurement of growth and yield of mushrooms. Improvement of mushroom strain and preparation of mushroom recipes.

*SSC(E)-422-Soil and Plant Health Clinic  

Cross listed with (MPP, EAZ & PPH)


UNIT- III Survey and collection of insect infested and diseased sample from various crops. Diagnosis of different insect pests and diseases. Seed health testing before sowing. Identification of new insect pests and plant pathogens.
MODULE –III HORTICULTURE

1. HOR(E)-421-Hi-tech Horticulture  5(0+5)

UNIT-I  Nursery raising of high value flower and vegetable crops.
   Off- season plants/plantlets production of horticultural crops.
   Plant production in low cost in polythene bags and in plastic perforated trays.
   Familiarization with construction materials of low cost shade nets and polyhouse.
   Greenhouse design, structure and technology for production of high quality planting materials.

UNIT-II  Use of various media in horticultural crops.
   Raising foliage plants in low cost structures.
   High density planting and management of horticultural crops.
   Micro-irrigation and fertigation in horticultural crops.
   Organic farming in horticulture.

UNIT-III  Production of Gerbera under protected condition.
   Production of cut roses in greenhouse.

UNIT-IV  Hi-tech plant protection/IPM strategies in horticultural crops.
   Recent developments in post-harvest management.

UNIT-V  Standards and grades in horticultural produce and products.
   Sanitary and phytosanitary measures for horticultural crops.
   Knowledge about logistics and policies for Hi-tech horticulture.

UNIT-VI  Visit to the Hi-tech horticulture units.
   Visit to the Flower Export Oriented Units.

HOR(E)-422-Commercial Floriculture  5(0+5)

UNIT-I  Identification of tools and implements

UNIT-II  Nursery raising of flower crops

UNIT-III  Bed preparation for rose cultivation
   Selection of rose varieties and planting techniques
   Care and management of rose plants
   Harvesting and handling of rose flowers

UNIT-IV  Selection of Gladiolus varieties, corms and corms treatment & planting techniques
   Care and management of Gladiolus
Harvesting of Gladiolus spike, grading and post harvest management
Harvesting of corms, cleaning grading and storage
Field preparation for marigold cultivation

UNIT-V Marigold seedling treatment and transplanting
Pinching and weeding of marigold field
Marigold flower harvesting, grading and value addition of marigold

UNIT-VI Production of filler crops
Seed production of important flower crops
Production techniques of annual and perennial chrysanthemum
Value addition and flower arrangements
Production techniques of tuberose

UNIT-VII Identification of pot plants, cut greens, foliage, succulents, high value foliages and palm, etc.

UNIT-VIII Visit to commercial flower production farm.

HOR (E)-423-Nursery Management of Horticultural Crops 5(0+5)

UNIT-I Method of plant propagation, sexual and asexual.
Layout of Model nursery of fruit crops.
Nursery and layout of annuals and perennials ornamental plants.

UNIT-II Crop calendar and nursery raising in vegetable crops.
Testing of seed viability and germination.
Seed treatment, stratification and scarification.
Use of plant growth regulators.

UNIT-III Raising root stock and propagules (Papaya) through seeds.
Multiplication of plants by cutting, layering, budding and grafting.
Propagation by modified root and stem.

UNIT-IV Propagation media, sterilization and bed preparation.
Plant propagation structure; net house, poly house, cold frame and hot frame.
UNIT-VI Hi-tech nursery and plant propagation through plugged plants.
UNIT-VII Lifting, packing, transport and marketing of nursery plants.
UNIT-VIII Visit to commercial nursery.
UNIT-IX Nursery Acts and Registration.
UNIT-I Different vegetable crops grown in India and preparation of vegetable calendar Identification of implements for vegetable gardening

UNIT-II Preparation of nursery bed (raised and flat bed) and seed/soil treatment Raising of nursery of tomato, brinjal, chilli, onion cabbage and cauliflower

UNIT-III Selection of site and layout of the field Application of manures and fertilizers Transplanting/sowing of important vegetable crops Development of irrigation schedule

UNIT-IV Application technique of herbicides, insecticides and fungicides List of improved varieties of vegetable crops List of important hybrid varieties of vegetables

UNIT-V To study the mode of reproduction in vegetable crops Study the floral biology of vegetable crops

UNIT-VI Development of vegetable hybrid seeds

UNIT-VII Identification of warm season vegetable crops

UNIT-VIII Application techniques of plant growth substances and micronutrients Determination of maturity indices in vegetable crops Cost benefit ratio of different vegetable crops

UNIT-IX Techniques of seed production of important vegetable crops Harvesting, cleaning, sorting, grading, and packaging of seeds Prescribed field/seed standards for vegetable seed production

UNIT-X Visit to commercial vegetable farm
**MODULE –IV Basic Science**

**GPB(E)- 422 Molecular Breeding**  5(0+5)

UNIT-I: Introduction to molecular plant breeding related laboratory equipments

UNIT-II: Demonstration of developed mapping population

UNIT-III: DNA isolation protocols

UNIT-IV: Handling of PCR

UNIT-V: Electrophoresis procedure

UNIT-VI: Computer based analysis of gel bands for mapping

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**GPB (E)-423 Microbial Technology**  5(0+5)

(Cross listed with MPP & SSC)

UNIT-I Isolation and cultivation of microorganisms (bacteria, fungi and algae)

UNIT-II MPN of Azospirillum and Rhizobium. Isolation of Azotobacter and PSM from typical soil.

UNIT-III Staining techniques and its application in identification.

Media formulation, microbial culture selection and optimization of fermentation process.


UNIT-V Evaluation of symbiotic nitrogen fixing ability in Rhizobium-legume association.

UNIT-VI Isolation of Pseudomonas fluorescens its mass production and delivery system.

Estimation of phytohormone production & phosphate solubilization.

**GPB(E) 424 Recombinant DNA Technology (GPB)**  5(0+5)

UNIT-I Introduction to recombinant DNA technology & handling laboratory tools and equipments

UNIT-II Bacterial culture (Agrobacterium) procedure

UNIT-III DNA isolation, purification and quantification

UNIT-IV Agarose gel electrophoresis

UNIT-V PCR-machine (Thermocycler) and its application

UNIT-VI Blotting techniques

**PPH(E)-421-Plant Tissue Culture (GPB, HORT. & PPH.)**  5(0+5)

*Cross listed with GPB & HOR

UNIT-I Basic requirements and knowledge of various equipments/accessories. Historical Perspectives. Media preparation and sterilization techniques.
(a) Media such as MS, Gamborges. Preparation stock solution.
(b) Glassware and explants sterilization.

Induction of callus from different parts of germinating seedlings.

Organ cultures in-vitro.

Hormonal applications and micropopagation of selected ornamental and medicinal plant using different ex-plants:

(a) Nodal segments
(b) – Shoot tips.

Abiotic stress tolerance in-vitro: salinity, drought etc.

UNIT-II  Initiation of suspension culture, its measurement, selection of mutant cells in vitro from culture cells.

Embryogenesis in carrot culture

Micropopagation of turmeric/ginger/potato/banana

Isolation of virus free plant of potato/tomato/tobacco

Protoplast culture and somatic hybridization: isolation of protoplast and fusion of protoplast from two different plant species.

Anther pollen and embryo culture from rice: induction of androgenic callus, haploid production, colchiplodization.

Genetic transformation

Cryopreservation of important plant materials.

UNIT-III  Regeneration protocol for:

(a) Ornamental crops: dahlia, chrysanthemum, tuberose, orchids, rose, carnation and gerbera.
(b) Fruit crops: banana, strawberry
(c) Vegetable crops: Asparagus, potato, sweet potato

Ovary and embryo culture for regeneration of interspecific crosses of horticultural crops. Anther culture (Cauliflower, broccoli, chillies, tomato, brinjal) and double haploid regeneration.

Visite to commercial micropopagation unit.
MODULE – V Agri-business Management

AEC (E)-421 Marketing Management 5(0+5)

Unit-I: Visit to regulated, cooperative and unregulated markets and preparation and presentation of project report.
Unit-II: Visit to organized retail market, corporate market and preparation and presentation of project report.
Unit-III: Visit of agro-based industries and documentation of marketing process, collection of marketing information.
Unit-IV: Documentation of product processing,
Unit V: Types of packaging materials used for packing of different products.
Unit VI: Study of marketing channels.
Unit VII: Marketing research, time series analysis, future trading etc.

AEC (E)-422 Financial Management of Agri-Business 5(0+5)

Unit – I: Visit to commercial banks, regional rural banks, NABARD, Cooperatives, NCDC and other financing agencies and preparation and presentation of report.

Unit – II: Visit to investment institution i.e. LIC, GIC, mutual funds, commercial bank, non-banking financial companies (NBFC), Agro-industries (Corporation, IDBI, IFCI, ICICI, SFCs, SIDCs) and micro-finance institution and preparation and presentation of report.


Unit – IV: Financial statement analysis and presentation: ration analysis, time series analysis, common size analysis, du-pont-analysis, breakeven analysis, difficulties associated with financial statement analysis.

Unit – V: Analysis and presentation of capital budgeting, payback period, average rate of return, net present value, benefit cost ratio, internal rate of return.

EXT (E)-421 Project Formulation, Evaluation and Monitoring 5(0+5)

UNIT-I Fundamentals of Project formulation and management: Procedure
for application, Project Description, Funding Information, Project Management.

UNIT-II Area survey and data collection: Guidelines for Data collection, Socio-economics Survey Formate.


UNIT-IV The logical Framework Approach to Project Planning: Basics of Logical Framework Approach (LFA), Understanding LFA terms, Advantage of LFA.

UNIT-V Collection of project application formats: Information about Implementing Agency, Information about Project. Application formats of various funding agencies.

UNIT-VI Monitoring and evaluation of project: Concept of Monitoring and Evaluation, Procedure of Evaluation.

EXT (E) 422 Information and Communication Management 5(0+5)

UNIT-I Concept and rationale for Information Management in Agriculture in general and Agricultural Extension in particular;

UNIT-II The history of Information Communication Technologies for Development (ICT4D); Issues related to ICT4D; Cyber Extension; Computer Literacy, Information Literacy, Media Literacy, ;

UNIT-III ICT enabled initiatives for Agricultural Development at National and international level; Success stories of ICT use in rural India; Hole in the wall, cybemohalla, wall project, mapping the neighbourhood;

UNIT-IV Market intelligence for farmers; Role of ICT in Entrepreneurship Development in Agriculture; Market survey and financial analysis of projects; Business management; Case studies of ICT application by farmers;

UNIT-V Organisational support for extension functionaries for ICT application in Extension service; User friendly software’s for Extension professionals;

UNIT-VI Hands on sessions for learning software packages; Project preparation by students;

UNIT-VII ICT mediated Knowledge management Experiments; Creation of crop
specific knowledge models and portals for effective management of information.
MODULE – VI  Bio Processing and Value Addition

ENG(E)-421 Cereals Processing  

UNIT-I: Determination of moisture content using oven method. Determination of moisture content using moisture meter.

UNIT-II: Unit operation for processing of paddy such as cleaning, grading, milling. Rice milling – traditional and modern methods.


UNIT-IV: To study different products from wheat.

UNIT-V: To study the storage characteristics of cereals such as rice, wheat. Visit to rice milling plants.

ENG(E)-422 Pulses and Oilseeds Processing  

UNIT-I: To study the physical properties of pulses and oilseeds. Determination of moisture content using oven method. Determination of moisture content using moisture meter.

UNIT-II: Unit operations such as cleaning, grading, drying, milling of pulses and oilseeds. Performance studies of separation methods. Performance studies on grading equipment.

UNIT-III: Determination of milling quality of pulses influenced by milling parameters. Determination of oil expression/extraction quality of oilseeds influenced by different parameters.

UNIT-IV: To study the storage characteristics of pulses and oilseeds. Visit to Dal mill and Oil mill.

*ENG(E)-423 Fruits, Vegetables and Dairy Products Processing  

Cross Listed with HOR & AHD

UNIT-I: To study the physical properties of fruits and vegetables. Study of separation methods. Drying of fruits and vegetables. Performance study of fruits/vegetables washer and green pea sheller.
UNIT-II: Performance study of peeler. Load deformation characteristic of fruits/vegetables. To study the production of fruit juice, RTS and juice concentrate by using RO system.

UNIT-III: To study the production of squash, jelly, jam, marmalades, pickles, cordial, tomato and potato products and bio-safety concerns. Comparative study of packaging materials for fruits and vegetables and their products.

UNIT-IV: To study the storage characteristics of fruits and vegetables-common storage, zero energy cool chamber, cold storage, controlled atmosphere storage, modified atmosphere storage. Visit to fruit/vegetable factory. Visit to cold storage.

UNIT-V: To study processing of milk, production of traditional dairy products and improvement in their packaging. Visit of Dairy Plant.

ENG (E)-424 Aromatic Plants and Spices Processing
(Cross listed with SSC) 5(0+5)

UNIT-I Collection and grading of medicinal and aromatic plants (roots, bark, leaf, flower and seeds). Processing of medicinal plant parts: air drying, over (hot air) drying, lypholization and grinding. Extraction of active parts: solvent extraction (soxhlet extraction), sonication, blending and super critical fluid extraction.